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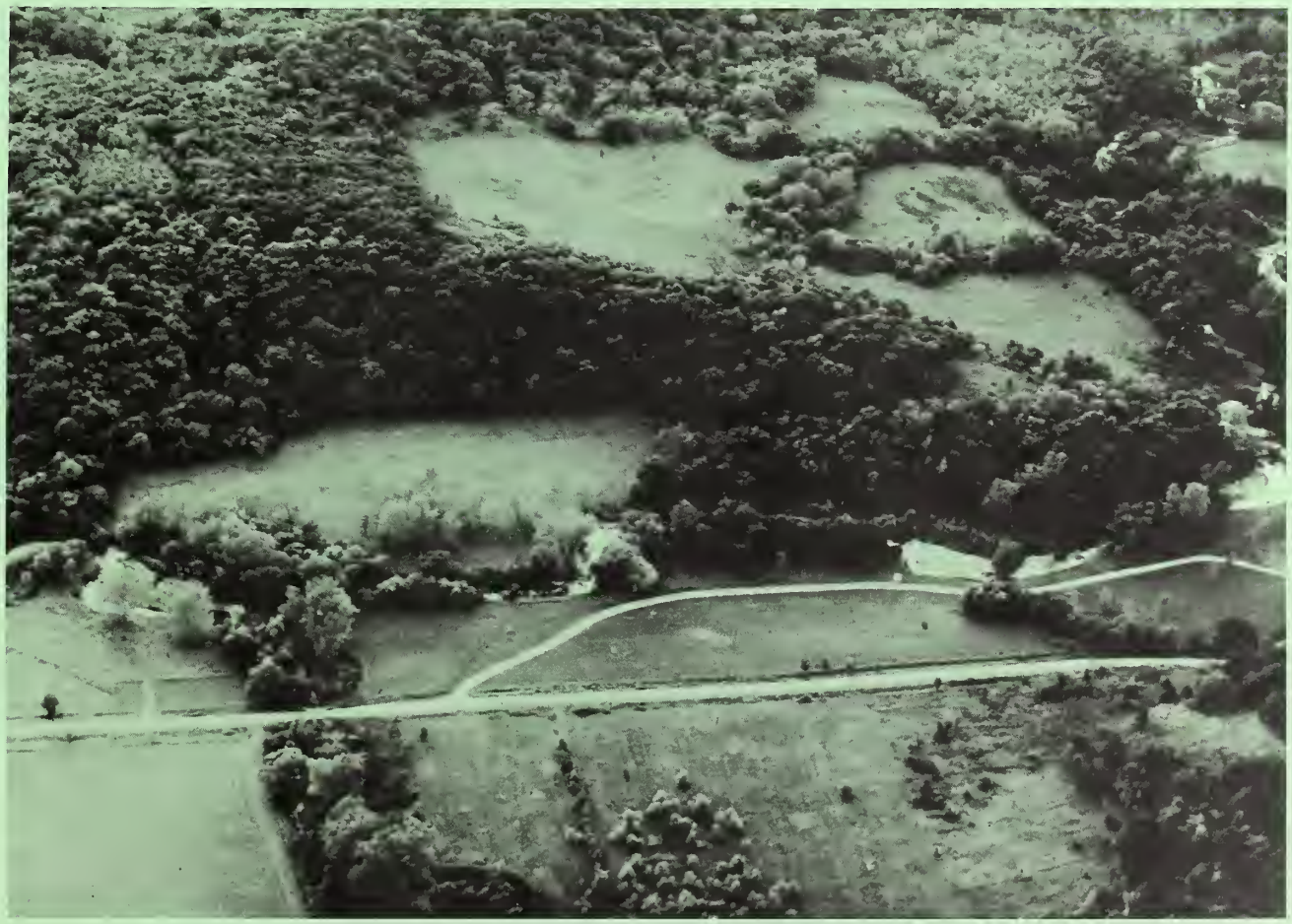
An Analysis of Iowa's Forest Resources, 1990

Earl C. Leatherberry, Sue M. Roussopoulos, and John S. Spencer, Jr.



North Central Forest Experiment Station
Forest Service—U.S. Department of Agriculture
1992 Folwell Avenue
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This report includes the most commonly used Forest Inventory and Analysis (FIA) statistics. Additional forest resource data can be provided to interested users. Persons requesting additional information that can be provided from the raw inventory data are expected to pay the retrieval costs. These costs range from less than $100 for a simple request to $2,000 for a complex retrieval involving the services of an FIA computer programmer. Requests will be filled to minimize the impact on the FIA project.

Requests for unpublished information may be directed to:

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FOREWORD

Forest Inventory and Analysis (FIA) is a continuing endeavor mandated by the Forest and Rangeland Renewable Resources Research Act of 1978. Inventories before 1978 were mandated by the McSweeney-McNary Forest Research Act of 1928. The objective of FIA is to periodically inventory the Nation's forest land to determine its extent, condition, volume of timber, growth, and removals. Up-to-date resource information is essential to frame forest policies and programs. USDA Forest Service regional experiment stations are responsible for conducting these inventories and for publishing summary reports for individual States. The North Central Forest Experiment Station is responsible for FIA activities in Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin.

Field work for the Iowa forest inventory began in May 1989 and ended in February 1990. The two previous inventories of Iowa's timber resource are dated 1954 and 1974 and are reported in Thornton and Morgan 1959 and Spencer and Jakes 1980, respectively.

The USDA Agricultural Stabilization and Conservation Service provided aerial photos used in the Iowa forest inventory. The year the photos were taken for each county is shown in the Appendix under the heading "Survey Procedures."

The following FIA reports on the 1990 Iowa inventory have been published (see Literature Cited for complete bibliographic information):

Brand and Walkowiak 1991
Smith and Tibben 1990

A complete set of Iowa inventory tables (except projections) is found in Brand and Walkowiak 1991. Leatherberry *et al.* 1992 (this report) contains only the core tables common to all eastern FIA statistical reports, in addition to projection tables and a few other tables.

Figures 1, 6, 11, 14, 19, 20, 24, and the cover photo are courtesy of the Iowa Department of Natural Resources.

The authors acknowledge the invaluable contributions of FIA aerial photo interpreters, office staff, and field crews to the Iowa forest inventory. Their hard work and commitment to accuracy are too often overlooked. This inventory could not have been accomplished without them.

HIGHLIGHTS

NOTE: *Comparisons of data from new forest inventories with data from earlier inventories indicate trends in forest resources. Comparisons are only valid if the procedures used in the two inventories are similar. Because of our ongoing efforts to improve the efficiency and reliability of the inventory, several changes in procedures and definitions have been made since 1974. Some of these changes make it inappropriate to directly compare the 1990 data with those published for 1974. Therefore, data from the 1974 inventory were reprocessed using the 1990 procedures and were published in part in the State statistical report (Brand and Walkowiak 1991). Please refer to the Appendix section labeled "Comparing Iowa's Third Inventory With the Second Inventory" for more details.*

Area

- Iowa's forest land area increased from 1.6 million acres in 1974 to 2.1 million acres in 1990. The increase reversed a steady and prolonged decline in forest area.

- Timberland area increased from 1.5 million acres in 1974 to 1.9 million acres in 1990. Much of the increase came from reversion of lands previously classified as wooded pasture or pasture with tree cover.

- Oak forest types account for 46 percent of Iowa's timberland area. The white oak-red oak-hickory forest type alone covers more area than any other type (37 percent). The largest increase was in the maple-basswood type, which gained 209 thousand acres (74 percent).

- Sawtimber-size stands extend over 65 percent of the timberland area, followed by poletimber and sapling-seedling stands with 20 and 15 percent, respectively. The area in sawtimber-size and poletimber-size stands increased between surveys; the area in sapling and seedling-size stands remained about the same

- Stands on 53 percent of the area are more than 50 years old.

- Site productivity is good. About half (939 thousand acres) of the timberland grows trees taller than 71 feet at age 50. The weighted average site index for all timberland area in the State is 70 feet.

- Nonindustrial private owners hold 92 percent of the State's timberland.

- Most of the private owners hold small parcels of timberland. Fifty-seven percent of the nonindustrial private timberland is held by owners with less than 50 acres of timberland.

- The number of growing-stock trees 5 inches d.b.h. and larger increased from 101 million in 1974 to 140 million in 1990, a gain of 39 percent.

Timber volume

- Growing-stock volume on timberland increased from 1.1 to 1.7 billion cubic feet between 1974 and 1990, a gain of 46 percent.

- Sawtimber volume increased from 3.8 to 5.8 billion board feet, a 53-percent gain.

- The Southeastern Survey Unit contains the largest volume of growing stock (787 million cubic feet), followed by the Northeastern Unit (659 million) and the Western Unit (217 million).

- Select white oak (334 million cubic feet), select red oak (189 million), soft maple (163 million), and cottonwood (150 million) are the species groups with the greatest volume of growing stock.

- In addition to growing stock, rough, rotten, and short-log trees account for 867 million cubic feet, and salvable dead trees account for 80 million cubic feet.

- Distribution of volume among diameter classes did not change significantly between inventories. Volume increased in all diameter classes.

- The greatest volume (31 percent of the total) is in stands that are 41 to 60 years old.

- Ninety percent of the growing-stock volume is in private ownership, with farmers holding 59 percent of the total.

- Growing-stock volume per acre increased from 782 to 856 cubic feet between inventories, a gain of 9 percent.

- Sawtimber volume per acre increased from 2,579 to 2,968 board feet between inventories, a gain of 15 percent.

- Two-thirds of the sawtimber volume is in the two poorest of the four tree grades used to classify quality.

Growth and Mortality

- Volume of current net annual growth of growing stock increased from 41.3 million cubic feet in 1973 to 50.9 million in 1989. The growth rate declined from 3.6 percent to 3.1 percent of inventory during the same period.

- Growing-stock growth per acre averaged 26 cubic feet in 1989, compared to 28 cubic feet in 1973.

- Average net annual growth of growing stock during the period 1974 to 1989 was 44.0 million cubic feet.

- Current net annual growth of sawtimber rose from 79.8 to 193.1 million board feet from 1973 to 1989. The growth rate increased from 2.1 to 3.3 percent of inventory during the same period.

- Sawtimber growth per acre averaged 55 board feet in 1973, but rose to 99 board feet in 1989.

- Average net annual growth of sawtimber during the period 1974 to 1989 was 196.9 million board feet.

- Average annual mortality of growing stock amounted to 16.1 million cubic feet during the period 1974 to 1989.

Removals

- Current annual growing-stock removals dropped from 50.3 million cubic feet in 1973 to 24.7 million cubic feet in 1988.

- Average annual growing-stock removals during the period 1974 to 1989 were 24.1 million cubic feet.

- Current annual removals of sawtimber fell from 163.3 million board feet in 1973 to 94.6 million board feet in 1988.

- Average annual sawtimber removals over the period 1974 to 1989 were 90.4 million board feet.

- Current removals amounted to 49 percent of current growing-stock growth and to 49 percent of sawtimber growth.

Biomass

- Aboveground biomass of live trees amounted to 136 million tons (green weight), an average of 70 tons per acre.

- Seventy-three percent of the biomass of live trees greater than 5 inches in diameter was in the boles of trees.

Projections

- The low removals option projection shows growing-stock inventory expanding from 1.7 to 2.1 billion cubic feet between 1990 and 2020, a 25-percent gain. Growth exceeds removals, and the two run roughly parallel throughout the projection period.

- The high removals option projection shows growing-stock inventory increasing only from 1.7 to 1.8 billion cubic feet from 1990 to 2020, a 10-percent gain. Growth exceeds removals, but the two approach each other during the projection period.

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An Analysis Of Iowa's Forest Resources, 1990

Earl C. Leatherberry, Sue M. Roussopoulos, and John S. Spencer, Jr.

Iowa is famous for its prairie landscape and agricultural-based economy. However, interspersed on the prairie, amid the cropland and along the rivers and streams, are pockets of forest. These pockets of forest have decreased in area and have changed dramatically over a relatively short period of time. Most of the changes in Iowa's forests were a result of agricultural policies and practices. Between 1832 and 1859, the period when the original land survey of Iowa was made, there were an estimated 7 million acres of forest land in the State (Davidson 1961). By 1954, the year of the first USDA Forest Service forest inventory of Iowa, forest land had declined to 2.4 million acres. In the span of about 100 years, an average of 46 thousand acres of forest land was lost each year as Iowa became one of the Nation's top producing agricultural States. Greater mechanization in farming further accelerated the decline in forest land. Between 1954 and 1974, forest land in Iowa declined by 34 percent to 1.6 million acres, much of which did not receive intensive management. Yet, Iowa's forests have proven to be an enduring natural resource. The State's forest lands are important sources of timber products, recreation opportunities, wildlife habitat, and erosion control (fig. 1).

Figure 1.—*The State's forests are places where some biological diversity is maintained in a mostly managed and cultivated landscape.*

This report describes the extent and condition of Iowa's forest resources as of 1990, in terms of forest area, timber volume, growth, mortality, and removals. Data from the previous State survey, dated 1974, will be used to assess changes between surveys. The 1974 data have been adjusted from those published after the 1974 inventory to account for changes in survey definitions.

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FOREST AREA INCREASES

In 1974, Iowa had 1.6 million acres of forest land, which made up 4.3 percent of the State's land area. In 1990, forest land covered 2.1 million acres, or 5.7 percent of the State's land area. The 31-percent increase in forest area between surveys reversed a steady and prolonged decline (fig. 2). Iowa joins its neighboring States of Minnesota, Missouri, Illinois, and Wisconsin in reporting increases in forest land area between their most recent surveys.

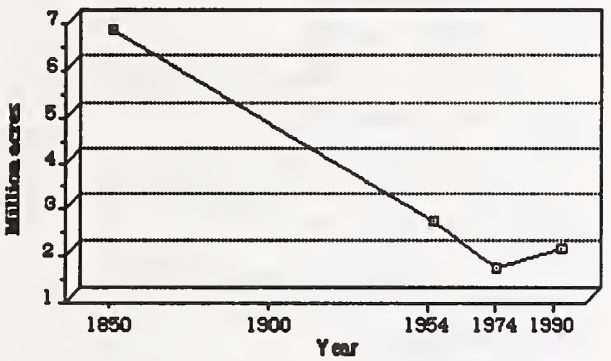

Figure 2.—*Changes in Iowa forest acreage since 1850.*

FOREST EXPANSION GREATER IN EASTERN IOWA

Iowa is divided along county boundaries into three Forest Survey Units (fig. 3). Most of the State's forest land is in eastern Iowa. The Southeastern Unit contains 49 percent (1 million acres) of the State's forest land, followed by the Northeastern Unit with 36 percent (742 thousand acres) and the Western Survey Unit with the remaining 15 percent (305 thousand acres). Forest land accounts for nearly 9 percent of the land area in the Southeastern Unit, 8 percent in the Northeastern Unit, and only 2 percent in the Western Unit. Most of the increase in forest land occurred in eastern Iowa. The Southeastern Unit recorded a 42-percent increase (295 thousand acres) in forest land. Although the Western Unit is only 2-percent forested, it had a 28-percent gain (66 thousand acres) in forest land between surveys. The Northeastern Unit posted a 21-percent gain (127 thousand acres) in forest land between inventories.

TIMBERLAND PREDOMINATES

Forest land is subdivided into three classes: (1) timberland, (2) reserved forest land, and (3) other forest land. (See Appendix for complete definition of terms.) Ninety-five percent (1.9 million acres) of Iowa's forest land was classified as timberland in 1990. Reserved forest land, primarily parks and conservation/natural areas, made up 4 percent (88 thousand acres) of the forest land base, a 16-percent increase between surveys. The remaining 1 percent (19 thousand acres) of the forest land base was other forest land, which decreased by 29 percent between surveys.

Wooded strips, which are too narrow to qualify as forest land but are important as windbreaks and shelterbelts, totaled another 132 thousand acres in 1990.

TIMBERLAND INCREASES BY ONE-THIRD

Between 1974 and 1990, the area of timberland increased by 33 percent (485 thousand acres) to 1.9 million acres. The primary reason for the increase is the reversion of pasture land to timberland. For instance, some land classified as wooded pasture in 1974 was re-classified as timberland in 1990 because there was no evidence of grazing. Between inventories, pasture land declined by 32 percent (1.1 million acres). A decline in pasture land—of 14 percent—has also been reported in neighboring Missouri (Spencer *et al.* 1992), which suggests a regional shift from pasturing cattle to feeding them in feedlots. Another reason for the increase in timberland is the increased trend in revegetating and reforesting riparian areas and highly erodible farm land. The Federal Government's Conservation Reserve Program provides an annual cash payment for 10 years to farmers who plant trees on their land instead of crops.

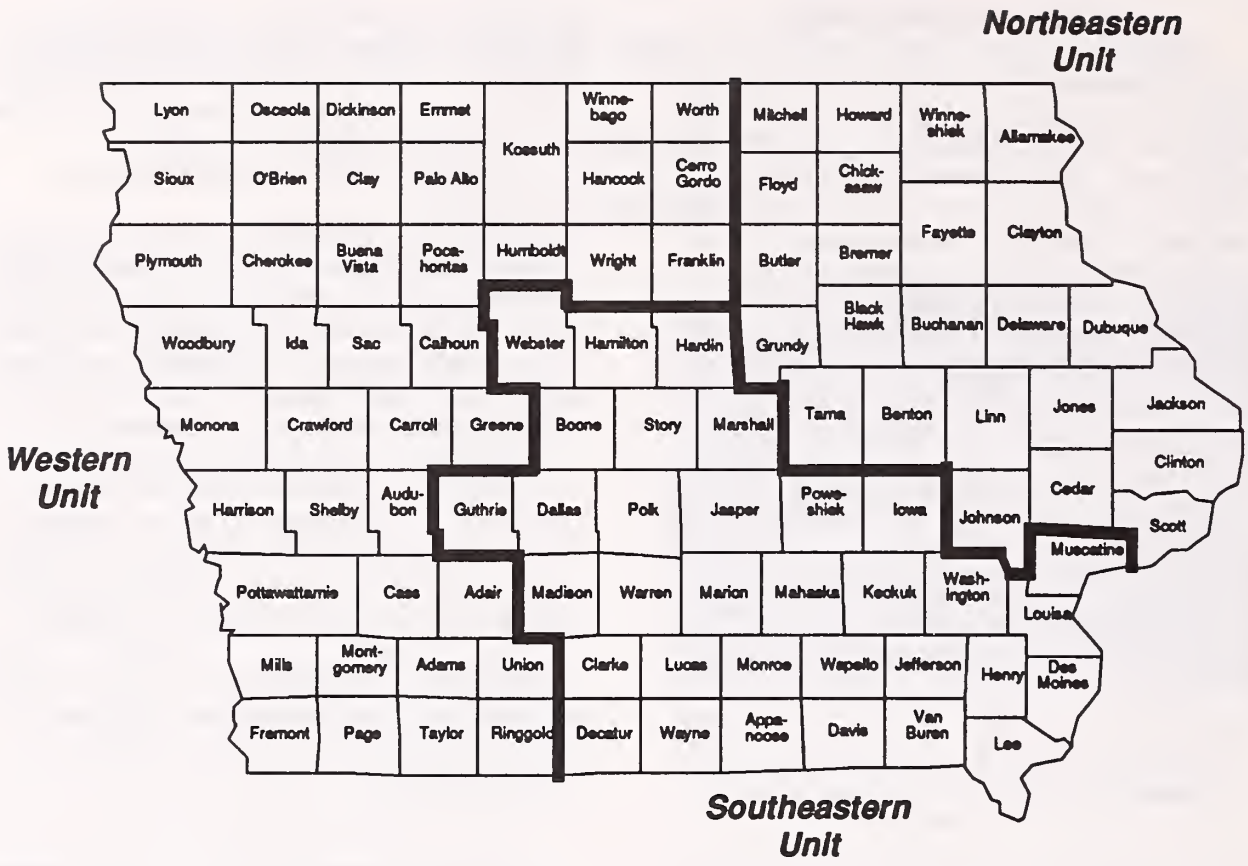

Figure 3.—Forest Survey Units in Iowa, 1990.

OAK TYPES DOMINATE TIMBERLAND

Iowa's timberland is mostly in hardwood stands, and the oak forest types dominate. The three oak types present in the State occupy 893 thousand acres (46 percent) of timberland. The largest component is in the white oak-red oak-hickory type, accounting for 721 thousand acres of timberland. Other major types are maple-basswood and elm-ash-soft maple, each accounting for about a fourth of the State's timberland area (fig. 4). Softwood forest types account for only 54 thousand acres, or 3 percent of the State's timberland area.

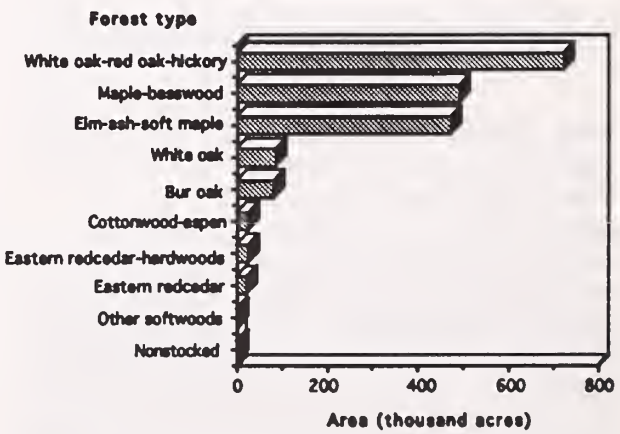

Figure 4.—*Area of timberland by forest type, Iowa 1990.*

MAPLE-BASSWOOD TYPE SHOWS LARGEST INCREASE

The composition of Iowa's timberland has been influenced by changes other than the conversion of pasture land to timberland since 1970. Table 1 presents an analysis of land classification changes from 1974 to 1990, based on the remeasurement of permanent sample plots. To use table 1—for example, to find what happened to the 558 thousand acres of white oak-red oak-hickory type present in 1974—simply read across the white oak-red oak-hickory row and find that 419

Table 1.--Forest land classification changes in Iowa, 1974-1990

(In thousand acres)

1974 land classification	1974 Area[2]	1990 land classification[1]													
		Timberland - forest type													
		Eastern redcedar	Eastern redcedar-hardwood	Other softwoods	White oak-red oak-hickory	White oak	Bur oak	Elm-ash-soft-maple	Cotton-wood-Aspen	Maple-Bass-wood	Non-stocked	Other forest land	Pasture & range	Cropland	Other
Timberland															
Eastern redcedar	19.7	17.0	--	--	--	--	--	--	--	--	--	--	--	--	2.7
E. redcedar-hardwood	15.0	2.2	--	--	6.3	--	--	--	--	6.5	--	--	--	--	--
Other softwoods	0.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
White oak-red oak-hickory	558.3	--	--	--	419.2	20.6	4.3	14.9	--	42.9	--	4.3	25.3	15.6	11.2
White oak	100.1	--	1.7	--	18.9	67.1	--	--	--	1.5	--	5.5	--	3.8	1.6
Bur oak	72.3	--	--	--	3.1	--	45.6	3.5	--	--	--	--	14.5	2.9	2.7
Elm-ash-soft maple	389.7	--	--	--	16.0	--	--	259.5	11.4	39.3	2.7	2.0	20.3	14.4	24.1
Cottonwood-aspen	21.3	--	--	--	0.5	--	--	--	14.5	1.9	--	--	--	4.4	--
Maple-basswood	282.3	--	--	--	41.2	--	2.2	9.1	3.2	188.7	--	--	11.3	20.0	6.6
Nonstocked	0.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Non-timberland															
Other forest land	102.6	--	3.0	--	3.5	--	2.8	7.2	--	3.2	--	82.9	--	--	--
Pasture & range	3,305.2	4.5	16.3	--	175.8	--	19.2	84.8	--	162.9	--	12.0	1,542.5	990.3	296.9
Cropland	28,352.9	--	2.9	6.3	17.7	--	3.8	46.7	--	26.3	--	--	559.9	27,332.3	357.0
Other	2,597.6	--	--	--	18.6	--	6.9	47.2	--	18.4	--	--	77.2	283.4	2,145.9
All land classes	35,817.0	23.7	23.9	6.3	720.8	87.7	84.8	472.9	29.1	491.6	2.7	106.7	2,251.0	28,667.1	2,848.7
Percent net change (1974-1990)		20.3	59.3	--	29.1	-12.4	17.3	21.3	36.6	74.1	--	4.0	-31.9	1.1	9.7

[1]Read across rows to determine dispersion of 1974 classes to 1990 classes. Read down columns to determine origin of 1990 classes.

[2]Total land area adjusted to conform to 1980 census figures.

thousand acres remained as white oak-red oak-hickory, 21 thousand converted to white oak, 4 thousand converted to bur oak, and so on. To determine the source of the 721 thousand acres of white oak-red oak-hickory present in the 1990 survey, read down the white oak-red oak-hickory column. Six thousand acres came from eastern redcedar-hardwood, 419 thousand acres were previously white oak-red oak-hickory, 19 thousand acres came from white oak, and so on. The maple-basswood type increased in area the most, gaining 209 thousand acres (74 percent), and was the second largest forest type in the State in 1990.

Four of every ten acres of timberland established since 1974 are in the maple-basswood type. The 492 thousand acres of maple-basswood present in 1990 includes 189 thousand acres that remained maple-basswood from 1974, as well as 44 thousand acres that converted from the oak types, 39 thousand acres that converted from the elm-ash-soft maple type, and 211 thousand acres that came from nontimberland—primarily pasture. Species associated with the maple-basswood type, particularly sugar maple and basswood, are prolific seed producers and are shade tolerant. When openings are created in the forest canopy, they are likely to succeed species associated with the oak types. Because of cutting, fire protection, and oak diseases, many stands formerly dominated by oak are tending toward other hardwoods, such as sugar maple. Also, sugar maple can reproduce through sprouting and root suckering; and when domestic livestock are removed from those sites, the species is likely to reproduce vigorously.

The white oak-red oak-hickory type gained 163 thousand acres (29 percent) from 1974 to 1990. Three of every ten acres of timberland established since 1974 are in the white oak-red oak-hickory type. Thirty percent (216 thousand acres) of the white oak-red oak-hickory acreage present in 1990 came from nontimberland, primarily from pasture. Twelve percent (86 thousand acres) converted from other forest types. The remaining portion—58 percent (419 thousand acres)—was in the type in 1974.

The elm-ash-soft maple type gained 83 thousand acres (21 percent) from 1974 to 1990. Fifty-five percent (260 thousand acres) of the elm-ash-soft maple acreage present in 1990 was in the type in 1974. Thirty-nine percent (186 thousand acres) converted from nontimberland. The remaining portion—6 percent (28 thousand acres)—converted from other types.

SAWTIMBER STANDS DOMINATE

In 1974, sawtimber stands extended over 59 percent of the timberland area. In 1990, sawtimber stands continued to dominate, growing on 65 percent of the timberland area, followed by poletimber and sapling-seedling stands on 20 and 15 percent of the timberland, respectively. Less than 1 percent of the timberland area was nonstocked in 1990. The area in sawtimber- and poletimber-size stands increased between inventories, while the area in sapling-seedling stands remained about the same (fig. 5). The substantial increase (48 percent) in sawtimber stands reflects the waves of trees growing out of poletimber size into sawtimber size between inventories. Also, some of the increase in sawtimber stands probably reflects a reduction in grazing and the reclassification of wooded pasture—often stocked with scattered, large sawtimber trees—to timberland.

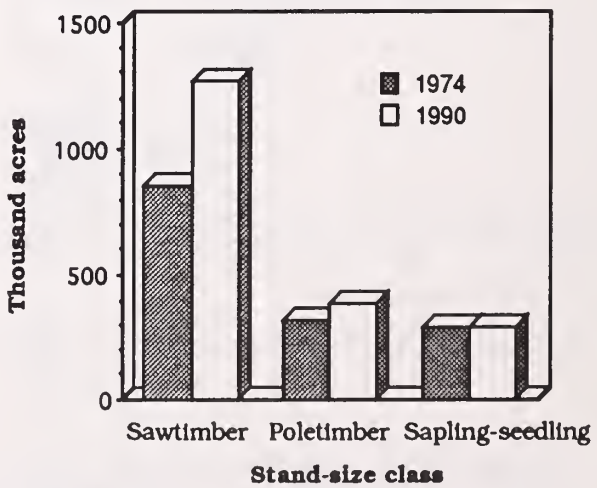

Figure 5.—*Area of timberland by stand-size class, Iowa, 1974 and 1990.*

Forest types with higher than average areas of sawtimber stands in 1990 were the three oak types combined (70 percent) and the elm-ash-soft maple type (69 percent). Forty-eight percent of the eastern redcedar type was in poletimber-size stands, which far exceeds the average for all types. The only other types to exceed the average in poletimber-size stands were the white oak-red oak-hickory type (22 percent) and the bur oak type (21 percent). All of the area classified as other softwoods was in sapling-seedling stands. Also, the eastern redcedar (16 percent), eastern redcedar-hardwoods (26 percent) and maple-basswood (26 percent) types had higher than average areas in sapling-seedling stands. Much of the area of eastern redcedar sapling and seedling stands developed because eastern redcedar is among the first trees to become established in abandoned fields and areas cleared for pasture (fig. 6).

Figure 6.—*An eastern redcedar sapling that has become established in an opening in Webster County.*

STANDS ON 53 PERCENT OF AREA OVER 50 YEARS OLD

Timberland stands in Iowa can generally be grouped into three broad age categories: stands 1 to 40 years old (32 percent of area), 41 to 80 years old (45 percent of area), and older than 81 years (23 percent of area) (fig. 7). However, stand age varies by forest type. The oak types, which consist of long-lived species, contain a greater proportion of area in older age classes. For instance, 81 percent of the white oak type is 51 years or older, and 55 percent is 81 years or older. Sixty percent of the white oak-red oak-hickory type and 75 percent of the bur oak type are more than 50 years of age. Other hardwood types are generally younger. For example, 59 percent of the maple-basswood type and 52 percent of the elm-ash-soft maple type are 50 years or younger.

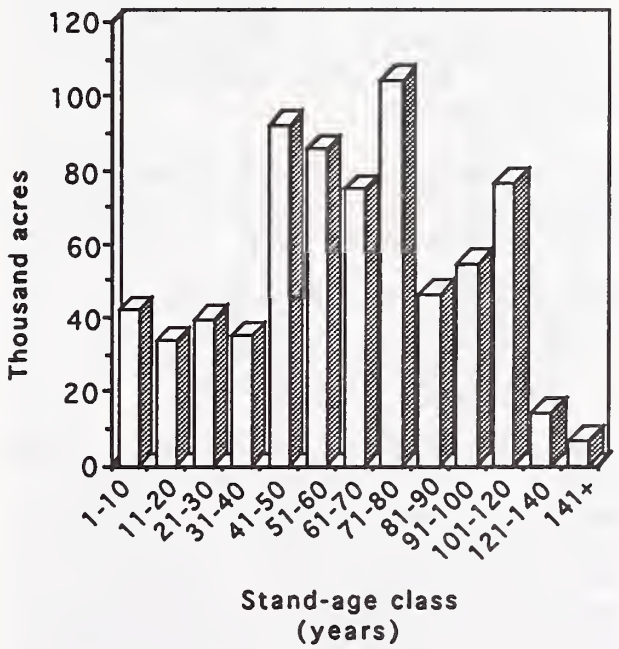

Figure 7.—*Area of timberland by stand-age class, Iowa, 1990.*

SITE PRODUCTIVITY GOOD

Site index is a measure of forest site quality based on the height attained by dominant and codominant trees of selected species at 50 years of age. Forty-eight percent (939 thousand acres) of the State's timberland grows trees 71 feet or taller at age 50, and 7 percent (145 thousand acres) of the total area grows

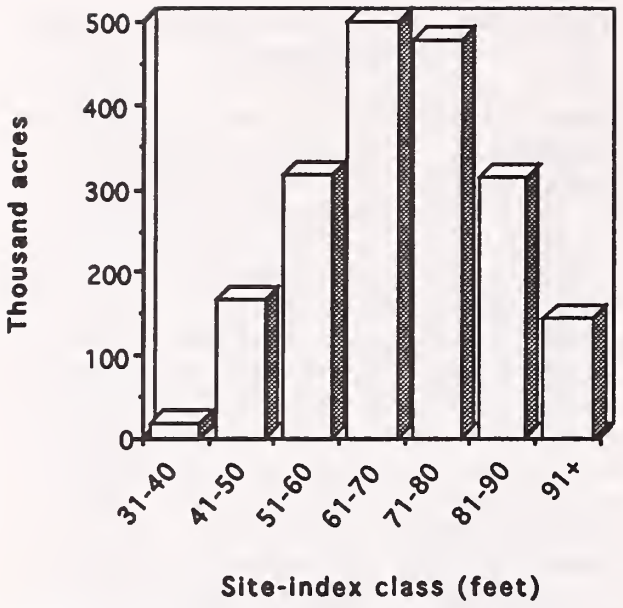

Figure 8.—Area of *timberland by site-index class, Iowa, 1990.*

trees 91 feet or taller (fig. 8). The weighted[1] average site index for all timberland area in the State is 70 feet, which does not vary by Forest Survey Unit.

Even though there is wide fluctuation among species, forest land in the Midwest can generally be categorized as follows:

Site index class	Description
55 or less	Low site
56 to 70	Average site
More than 70	High site

Site index values vary among forest types. For instance, among Iowa's oak forest types, the weighted average for white oak-red oak-hickory is 68 feet, followed by white oak (60 feet) and bur oak (59 feet). For the North Central States, Sander (1977) identified three broad classes of oak sites. Oak sites with indices greater than 75 are good sites, those between 55 and 74 are average sites, and those between 40 and 55 are poor sites. Much of Iowa's oak forest types are considered to be on average sites.

[1] *Weighted by the number of acres in each site-index class.*

[2] *Culmination of mean annual increment is the point at which a curve plotting current annual increment crosses a curve plotting mean annual increment. Culmination of mean annual increment indicates the age at which average annual growth is the greatest, and thus, the rotation age of maximum volume-growth productivity.*

Potential productivity class, another means of characterizing site quality, describes timberland in terms of its inherent capacity to grow wood based on culmination of mean annual increment in fully stocked, natural stands.[2] Potential productivity class values are expressed as cubic feet of growth per acre per year that might be expected under these conditions. In 1990, an estimated 34 percent (656 thousand acres) of Iowa's timberland was capable of producing 85 cubic feet per acre per year or more (fig. 9). Another 47 percent (911 thousand acres) could produce between 50 and 84 cubic feet per acre per year. The remaining 19 percent (377 thousand acres) of Iowa's timberland was capable of producing between 20 and 49 cubic feet per acre per year. The weighted average potential productivity for all forest types in Iowa was 75 cubic feet per acre per year in 1990, compared to 80 for Illinois, 54 for Missouri, and 55 for Minnesota. The elm-ash-soft maple forest type had an average potential productivity of 78 cubic feet per acre per year, followed by the white oak-red oak-hickory type (76 cubic feet) and the maple-basswood type (75 cubic feet). Weighted averages by Survey Units ranged from 69 in the Western Unit, to 74 and 78 in the Southeastern and Northeastern Units, respectively. The eastern two Units have deeper and more fertile soils than the dryer loess hills common in western Iowa, which may explain the regional variability in potential productivity class.

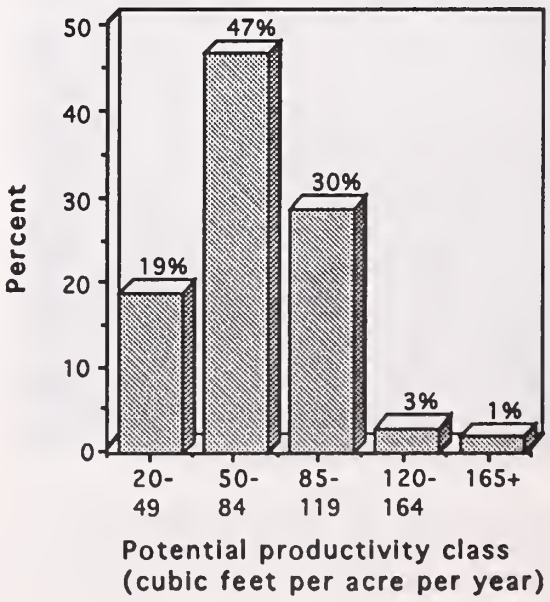

Figure 9.—*Percent of timberland area by potential productivity class, Iowa, 1990.*

MOST TIMBERLAND IN PRIVATE OWNERSHIP

Ninety-two percent (1.8 million acres) of Iowa's timberland is privately owned, primarily by farmers and private individuals (fig. 10). Most of these owners hold small parcels of timberland. For instance, 57 percent (1 million acres) of the private timberland is held by owners with less than 50 acres, and 86 percent (1.5 million acres) is held by owners with less than 100 acres.

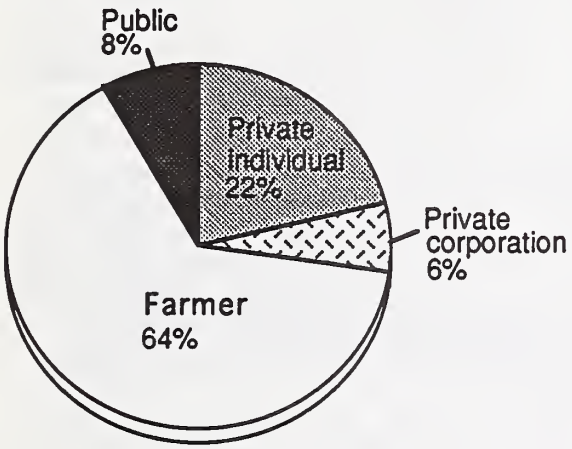

Figure 10.—*Ownership of timberland, Iowa, 1990.*

The length of time timberland has been held by the same owner varies. Thirty percent of the privately owned timberland in Iowa has been held by the same owner for more than 20 years, and 24 percent has been held by the same owner for less than 5 years. However, most (55 percent) of the private timberland held for more than 20 years is owned by persons with more than 50 acres of timberland.

The size of timberland area owned and the length of ownership have implications for public assistance programs to timberland owners for timber management. Long-term timberland owners are more likely to undertake timber management projects because they generally know more about assistance programs. In addition, those programs may be targeted for owners of large tracts of timberland. But, much of the timberland in Iowa is in small, fragmented pockets, and research shows that small-tract timber owners are less likely to be aware of assistance programs than are large-tract owners (Bliss 1991).

The 8 percent (156 thousand acres) of timberland that is public-owned in Iowa is largely held by State and local governments. Only 44 thousand acres of timberland are federally owned.

STOCKING LEVELS IMPROVE

Stocking, a relative measure of tree density on the land, provides a means of describing how fully trees are occupying a site. Fifty-nine percent (1.1 million acres) of the timberland area is moderately or fully stocked with growing-stock trees, and less than 1 percent (12 thousand acres) is overstocked. Stocking levels have improved since the 1974 survey when 43 percent (627 thousand acres) of the timberland area was moderately or better stocked with growing-stock trees. Much of the poor stocking in the past was the result of heavy grazing, which has declined. The level of stocking on farmer-owned timberland is somewhat lower than that on land held by other owners. This may be partly because of the effects of grazing, which is more likely on land held by farmers. Forty-six percent (567 thousand acres) of the timberland owned by farmers is poorly stocked or nonstocked (less than 16.7 percent stocked) with growing-stock trees, but only 31 and 35 percent of the stands in other private and public ownership, respectively, are poorly stocked or nonstocked.

Stocking levels vary by geographic region. In western Iowa, where tree-growing conditions are harsher, 61 percent of the timberland acreage is poorly stocked or nonstocked, compared with 32 percent in the Northeastern Unit, and 41 percent in the Southeastern Unit.

NUMBER OF GROWING-STOCK TREES INCREASES

The number of growing-stock trees 1.0 inches in diameter and larger increased from 395.9 million in 1974 to 582.4 million in 1990, a 47-percent gain. During the same period, growing-stock trees 5.0 inches in diameter and larger increased from 100.8 million to 140.0 million, a gain of 39 percent. Nearly all

species increased in number of trees. As shown in table 1, however, the area of the white oak type is the only type that declined between inventories, and this area loss was also reflected in a decline in the number of growing-stock trees. The white oak group (both select white oak and other white oak) had a 14.9 percent loss in the number of growing-stock trees (all diameter classes) between inventories.

TIMBER VOLUME GREATLY INCREASES

The net volume of growing stock on timberland in Iowa increased from 1.1 billion cubic feet in 1974 to 1.7 billion cubic feet in 1990, a gain of 46 percent. The Northeastern and Southeastern Survey Units gained 173.0 (36 percent) and 281.1 (56 percent) million cubic feet, respectively, while the Western Unit gained 67.6 million cubic feet (45 percent). Sawtimber volume increased 53 percent from 3.8 billion board feet[3] in 1974 to 5.8 billion board feet in 1990.

Several interrelated factors contributed to the volume increase. As mentioned earlier, the total number of growing-stock trees at least 5.0 inches in d.b.h., which contribute to volume, increased from 100.8 million to 140.0 million. The increase in number of trees occurred across all diameter classes and is a result of ingrowth and maturation, as well as the 33-percent increase in timberland area.

The bulk of the increase in timberland area came from the reclassification of lands that had been wooded pasture or improved pasture. Table 1 shows that 463.5 thousand acres of land classified as pasture and range in 1974 was classed as timberland in 1990. Nearly three-quarters of this reclassified land is now in the white oak-red oak-hickory and maple-basswood forest types. An estimated 160 million cubic feet of growing stock was added between inventories from land classed as wooded pasture or improved pasture in 1974, but reclassified as timberland in 1990. Stocking on these converted acres is often low, but one-third of the above 160 million cubic feet is in trees at least 18 inches in d.b.h.

[3] *International 1/4-inch rule.*

Declining removals also played a part in Iowa's increasing inventory. Average annual removals declined by 52 percent from 50.3 million cubic feet in 1973 to 24.1 million cubic feet for the period from 1974 to 1989. Average annual removals were 55 percent of average net annual growing-stock growth during the period.

VOLUME CONCENTRATED IN EASTERN IOWA

Eighty-seven percent of Iowa's growing-stock volume is found in the eastern two Survey Units, which account for 57 percent of land area. Eastern Iowa receives more rainfall and is more conducive to tree survival and growth than the western parts of the State, which are dominated by cropland. The Northeastern and Southeastern Survey Units contain 659.0 (40 percent) and 786.7 (47 percent) million cubic feet of growing stock, respectively. The remaining 13 percent of growing stock (217.3 million cubic feet) is in the Western Survey Unit, which accounts for 43 percent of Iowa's land area.

OVER ONE-THIRD OF VOLUME IN OAK

Hardwoods make up 99 percent (1.6 billion cubic feet) of the growing-stock volume—a percentage that has not changed since the 1974 survey. Oak species accounted for 614.1 million cubic feet of volume in 1990, compared to 457.2 million cubic feet in 1974, an increase of 34 percent (fig. 11). The select white oak group (primarily white and bur oaks) totals 334.3 million cubic feet, and

Figure 11.—*A white oak sawtimber stand in southern Iowa.*

select red oak (northern red oak) makes up 188.5 million cubic feet. Of the remaining oak volume, 89.5 million cubic feet is in the other red oak group (primarily black oak) and 1.7 million cubic feet is in the other white oak group (primarily post oak).

The ranking of individual species groups in 1990 and their volumes in 1974 is shown in figure 12. Black walnut, which ranked 12th in volume in 1974, moved up to 9th place in 1990. Only 1 percent of the growing-stock volume is in softwoods, 98 percent of which is eastern redcedar. Redcedar made significant volume gains, increasing by 174 percent between 1974 and 1990.

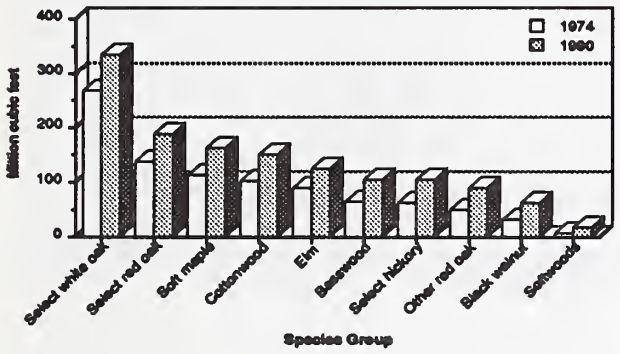

Figure 12.—*Net volume of growing stock on timberland by major species groups, Iowa, 1990.*

The volume of oaks increased 34 percent from 1974 to 1990, but the volume of other hardwood species increased 52 percent over the same period. Although still a major component of growing-stock volume, oaks represented a smaller proportion of total hardwood volume in 1990 (37 percent) than they did in 1974 (40 percent). This reflects the high demand for oak products compared to other hardwoods—oaks accounted for 38 percent of average annual hardwood removals from 1974 to 1989—and the relatively slow growth rate of oaks in general.

Several species or species groups of low economic interest increased dramatically in volume from 1974 to 1990. Hackberry gained 231 percent (from 17.2 to 57.1 million cubic feet). The other softwoods group increased 208 percent from 0.1 to 0.3 million cubic feet, and as noted above, eastern redcedar gained 174 percent. As impressive as these gains seem, together these three species (groups) still make up less than 5 percent of Iowa's 1990 growing-stock volume.

The net volume of sawtimber in Iowa was 5.8 billion board feet in 1990. The ranking of sawtimber by species group differs slightly from that of growing-stock volume. Select white oak and select red oak still rank first and second in sawtimber volume, but cottonwood moves past soft maple for third place, and basswood moves ahead of elm for the fifth spot.

Although most of the volume of a species group is commonly found in stands of the forest type associated with that species group, (*i.e.* select white oaks in the white oak type), substantial volumes can occur in other types. For example, 26 percent of the growing-stock volume in the maple-basswood forest type is composed of oak and hickory species groups. This is an indicator of the succession of more mesic sites from the oak-hickory type to the maple-basswood type. Forty-nine percent of the cottonwood volume is in the elm-ash-soft maple type, and only 37 percent is in the cottonwood-aspen type. Elm volume is particularly scattered, with 37 percent in the maple-basswood type, 29 percent in the white oak-red oak-hickory type, and 28 percent in the elm-ash-soft maple type.

NONGROWING-STOCK TREES ADD TO VOLUME

In addition to the 1.7 billion cubic feet of growing-stock volume, Iowa has 867.0 million cubic feet of cull (rough, rotten, and short-log trees) and 79.7 million cubic feet of salvable dead trees (fig. 13). This brings the net volume of timber on timberland to 2.6 billion cubic feet. Nongrowing-stock trees are an important component of the forest because they stabilize the soil; provide feeding, roosting, and nesting sites for wildlife; supply forest products; and make up part of the nutrient and energy cycle.

Eighty-eight percent (763.6 million cubic feet) of the nongrowing-stock volume is made up of rough and short-log trees[4]. The ratio of growing-stock to rough and short-log volume

[4] *Sawtimber-size trees that contain at least one 8- to 11-foot saw log, but not a 12-foot saw log.*

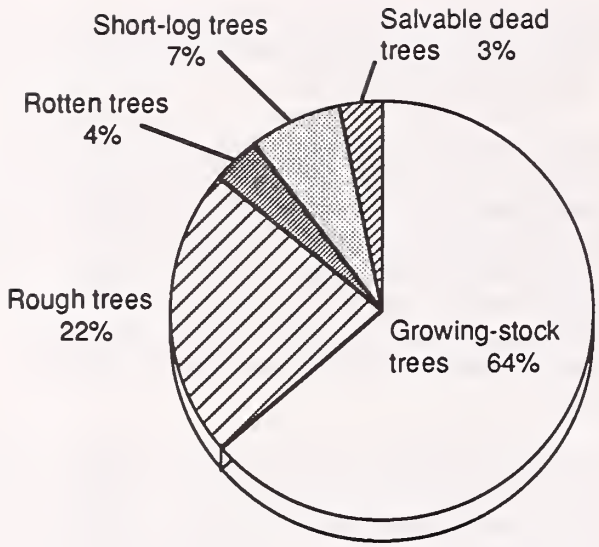

Figure 13.—*Distribution of volume among timber classes.*

is 2.2 to 1, the same as in Missouri, in comparison to ratios of 10.0 to 1 in Minnesota and 11.6 to 1 in Illinois. These figures underscore the reality that Iowa is on the prairie fringe where conditions for tree growth can be difficult.

Although nongrowing-stock trees may be unsuitable for some timber products, a substantial volume is used. For example, 12 percent (1.5 million cubic feet) of Iowa's 1988 output of roundwood industrial products was produced from cull and salvable dead trees. Saw logs accounted for most of this volume. In addition to this industrial output, 9.8 million cubic feet of fuelwood, or 32 percent of that produced in Iowa, is supplied by nongrowing-stock trees (fig. 14).

VOLUME INCREASES IN ALL DIAMETER CLASSES

Growing-stock volume in every diameter class increased between 1974 and 1990 (fig. 15). In general, volume in trees in the 12-inch diameter class (11.0 to 12.9 inches) and larger increased faster (52 percent) than trees in the 6-inch through 10-inch classes (32 percent). For instance, volume in trees in the 18-inch diameter class showed a gain of 60 percent, compared to an increase of only 26 percent in volume in trees in the 8-inch diameter class. Trees 12 inches in diameter and larger had

Figure 14.—*A small sawtimber white oak tree with a rotten base that may prevent the tree's use for industrial timber products, but not for fuelwood.*

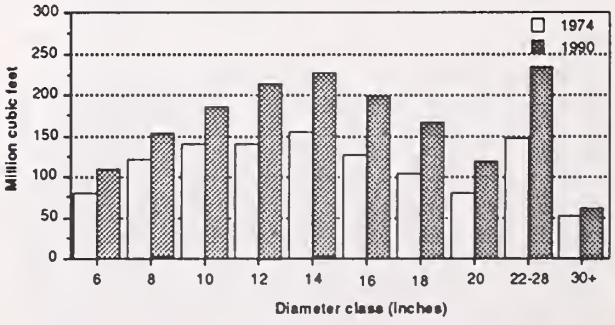

Figure 15.—*Distribution of growing-stock volume among diameter classes, Iowa, 1974 and 1990.*

faster rates of ingrowth into the next largest diameter class than did smaller trees, which helps explain why sawtimber volume increased faster than growing-stock volume between inventories. The weighted average tree diameter for all diameter classes was 4.1 inches in 1990, slightly less than the 4.3 inches estimated in 1974. However, if only trees 5.0 inches in diameter and larger are considered, the weighted average diameter is 9.6 inches, slightly larger than the 9.5 inches in 1974.

Eighty-four percent of the eastern redcedar volume, as well as 54 percent of the elm volume, is in trees less than 11.0 inches d.b.h. Eastern redcedar is invading areas that were formerly grazed, and large elms have been decimated by Dutch elm disease. Cottonwood volume is heavily concentrated in the large diameter classes; nearly 70 percent is in trees 19.0 inches d.b.h. and larger. Only 12 percent of select red oak volume is in diameter classes 10 inches and smaller, compared to 28 percent of all other hardwoods. This, along with the proportionally small number of trees in the lower diameter classes for oaks, could point to future shortages and higher stumpage prices if demand for oak remains high. Thirty-two percent of the select red oak volume, as well as 39 percent of the soft maple volume, is in trees 19.0 inches d.b.h. and larger.

NEARLY ONE-THIRD OF VOLUME IN STANDS 41 TO 60 YEARS OLD

Thirty-one percent of the growing-stock volume is in stands aged 41 to 60 years, more than in any other age class (fig. 16). The area of timberland in the 41- to 60-year age class is also the largest, although it represents only 26 percent of timberland area. Eleven percent of the volume is in stands older than 100 years. From a timber production standpoint, these stands are mature to overmature and are probably declining in vigor. However, more than 70 percent of this volume is in oak-hickory forest types, which are generally long lived and hold their value well. It is also worth noting that large, old trees are a natural part of a diverse forest landscape. They are pleasing to the eye and provide important wildlife habitat.

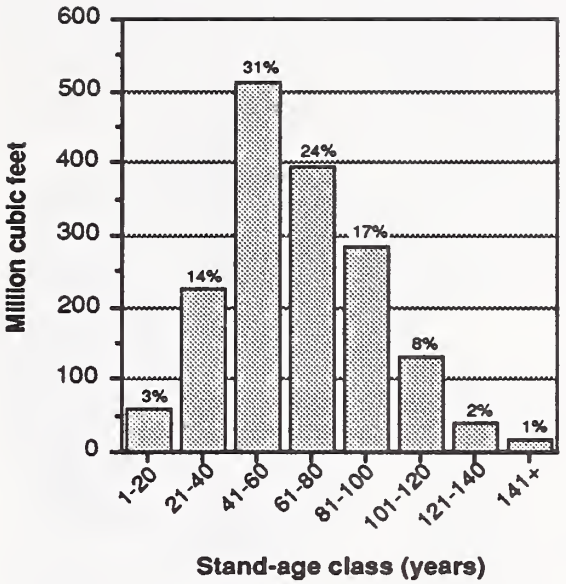

Figure 16.—*Distribution of growing-stock volume among age classes, Iowa, 1990.*

MOST VOLUME IN PRIVATE OWNERSHIP

Ninety percent (1.5 billion cubic feet) of Iowa's growing-stock volume is in private ownership; farmers hold two-thirds of that total (fig. 17). The remaining 10 percent is in various public ownerships: Federal, State, county, and municipal. Volume in all ownerships increased during the survey period but at different rates. Farmer-owned growing-stock volume increased 35 percent, compared to a 73-percent increase on other private land. Farmers may be more inclined to clear land, to harvest timber needed for farm use, or to harvest timber to raise cash in poor crop years. As a result, farmers, who continue to own the most volume, saw their portion of total volume decline from 64 to 59 percent in 1990, while other private ownership increased from 26 to 31 percent. Public ownership held steady at 10 percent of volume.

VOLUME PER ACRE INCREASES

The average growing-stock volume per acre on all timberland was 856 cubic feet in 1990, compared to 782 cubic feet per acre in 1974, an increase of 9 percent. This compares to average volumes per acre of 672 cubic feet in Missouri, 1,022 cubic feet in Minnesota, and

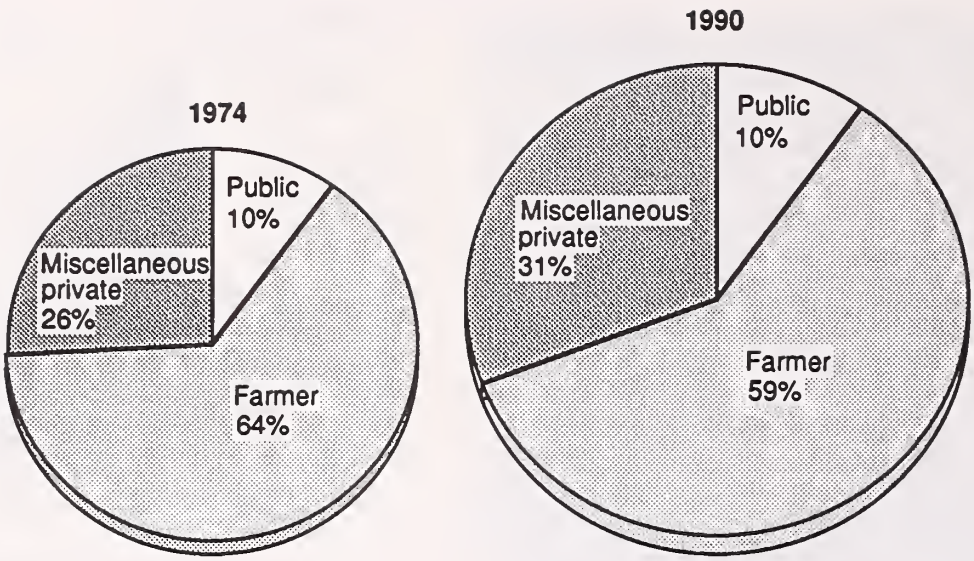

Figure 17.—*Distribution of growing-stock volume among ownership classes, Iowa, 1974 and 1990.*

1,200 cubic feet in Illinois. Although average volume per acre on public lands declined by 5 percent to 1,051 cubic feet, it remains higher than the 839 cubic feet average on private land. All forest types remained stable or increased in volume per acre between surveys, except for the maple-basswood type, which declined from 751 to 672 cubic feet per acre. This decline was probably due to the increase of lightly forested timberland in this type. The highest average volume per acre by far—2,409 cubic feet—occurs in the cottonwood-aspen type.

The average sawtimber volume per acre increased from 2,579 to 2,968 board feet between inventories, a 15-percent gain.

SAWTIMBER QUALITY IS POOR

On approximately half of the sample plots, the butt log section of each sawtimber sample tree was graded to estimate sawtimber quality (see Tree/Log Grade in Appendix). Sixty-six percent (3.8 billion board feet) of Iowa's sawtimber volume is in the two poorest grades; 22 percent (1.3 billion board feet) is in grade 2; and 12 percent is in grade 1 (fig. 18).

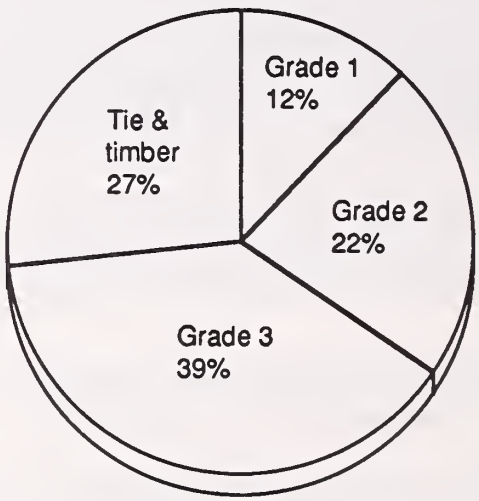

Figure 18.—*Net volume of hardwood sawtimber by tree grade, Iowa, 1990.*

The presence of more than the accepted number of knots is the primary reason tree grades are not better in Iowa. Knots (or the absence of clear cuttings in the bole) prevented 66 percent of grade 2 tree volume from being classed as grade 1, followed by tree diameter too small to meet minimum standards for grade 1 (17 percent), and a combination of knots and tree diameter (9 percent). Other limiting factors were cull, sweep and crook, and length of bole.

Forty-four percent of the select red oak volume is in grades 1 and 2, compared to 26 percent of other oak species groups. Other species groups that have relatively large volumes in grades 1 and 2 are cottonwood (58 percent), basswood (51 percent), black walnut (50 percent) and hackberry (49 percent) (fig. 19).

Figure 19.—*A high-quality black walnut sawtimber tree on deep bottomland soils.*

VOLUME OF GROWTH INCREASES

Current[5] net annual growth of growing stock increased from 41.3 million cubic feet in 1973 to 50.9 million cubic feet in 1989, a 23-percent gain. Average net annual growth of growing stock during the period 1974 to 1989 (periodic growth) was 44.0 million cubic feet. The volume of growing-stock growth, then, was greater at the end of the period than the average for the period. Current net annual growth of sawtimber surged from 79.8 million board feet in 1973 to 193.1 million board feet in 1989, a 142-percent increase. Average net annual growth of sawtimber during 1974 to 1989 was 196.8 million board feet. The volume of sawtimber growth in 1989 slowed from the average for the period.

The big increase in sawtimber growth, compared with the more modest increase in growing-stock growth, is primarily due to a continuing shift in the tree population to those of larger diameters. As discussed earlier, the rate of ingrowth is higher for trees at least 12 inches d.b.h. than for smaller trees. A substantial volume was added between inventories from lands formerly classed as wooded pasture, on which there were large trees. Thirty percent of the sawtimber growth during 1974 to 1989 can be attributed to ingrowth, compared with only 10 percent of the growing-stock growth.

The current growth rate for growing stock (growth as a percent of inventory) declined from 3.6 percent in 1973 to 3.1 percent in 1989. The sawtimber growth rate rose from 2.1 to 3.3 percent during the same period. The growing-stock growth rate during the period 1974 to 1989 (based on the average growing-stock inventory between 1974 and 1990) averaged 3.1 percent. The sawtimber periodic growth rate during the same period averaged 4.1 percent.

Periodic growth rates for growing stock vary little across the State, ranging from 2.9 percent in the Northeast Survey Unit to 3.2 and 3.3 percent in the Western and Southeastern Units, respectively. Among species groups with substantial growing-stock volume, the periodic growth rates for elm (4.8 percent) and soft maple (4.6 percent) are substantially above the State average of 3.1 percent. Select red oak and select white oak, at growth rates of 2.3 and 1.8 percent, respectively, are well below the State average.

Another measure of growth is the volume of growth per acre. Growing-stock current growth averaged 28 cubic feet per acre in 1973 and dropped to 26 cubic feet in 1989.

[5] *Current growth, the volume of growth for a single year, will be used in this paper to compare growth between the old and new inventories. Periodic growth, the average volume of growth throughout the period between the old and new inventories, will be used in this paper to compare growth by Survey Units, species, etc. for the new inventory.*

Sawtimber current growth per acre rose from 55 board feet in 1973 to 99 board feet in 1989. Average net annual growth per acre of growing stock over the period 1974 to 1989 ranged from 23 cubic feet in the Western Unit to 27 cubic feet in the Southeastern Unit. Average net annual growth per acre of sawtimber over the same period was also lowest in the Western Unit (87 board feet), but highest in the Northeastern Unit (125 board feet).

Adding average annual mortality for the period 1974 to 1989 of 16.1 million cubic feet to net growth provides an estimate of gross growth equal to 60.1 million cubic feet. Average net annual growth is 73 percent of average gross growth. The ratio of gross growth to net growth varies among the major species groups; elm is at the low end (49 percent), and black walnut is at the high end (93 percent). Elm stands out because of its high mortality between inventories, primarily because of Dutch elm disease.

POTENTIAL GROWTH MUCH GREATER THAN ACTUAL

The potential for net annual growth in Iowa is roughly estimated to be 131 million cubic feet per year, or 67 cubic feet per acre (table 2). This estimate is based on the distribution of timberland area by potential productivity class, a means of describing forest land in terms of its inherent capacity to grow crops of industrial wood, based on fully stocked natural stands. Timberland area in each productivity class was multiplied by the midpoint of the class to give an estimate of annual potential growth in Iowa of 145 million cubic feet. This is an exaggerated estimate because many stands are neither fully stocked nor natural (unmanaged and uncut). To account for this disparity between natural, unmanaged stands and actual stand conditions, total potential growth was discounted by 10 percent after the manner of Spurr and Vaux (1976).

The adjusted potential growth of 131 million cubic feet per year is simply a crude estimate, but it is triple the net annual growth of 44 million cubic feet observed between 1974 and 1989. Stocking control, crop tree release, pruning, and planting of improved genetic stock are among the intensive management practices that would move average annual growth toward potential growth.

MORTALITY MORE THAN DOUBLES

During the period 1974 to 1989, annual mortality of growing stock averaged 16.1 million cubic feet, compared to an average of 6.9 million cubic feet in 1973. Sawtimber mortality averaged 43.4 million board feet per year between surveys; it amounted to 25.7 million board feet in 1973.

Table 2.—*Estimation of potential net annual growth on timberland, Iowa, 1990*

Potential productivity class (Ft^3/ac/yr)	Timberland Area	Potential net growth per acre[1]	Total potential growth[2]	Adjusted total potential growth[3]
	Thousand acres	*Ft^3/ac/yr*	*- - - - - - Million ft^3/yr - - - - - -*	
165+	22.6	194.5	4.4	4.0
120-164	59.7	142.0	8.5	7.6
85-119	573.2	102.0	58.5	52.6
50-84	911.4	67.0	61.1	55.0
20-49	376.6	34.5	13.0	11.7
	1,943.5		145.5	130.9

[1] Midpoint of potential productivity class.
[2] Area multiplied by potential net growth per acre.
[3] Total potential growth discounted by 10 percent.

The growing-stock average annual mortality rate was 1.1 percent of the 1990 inventory or 9 cubic feet per acre per year. The sawtimber mortality rate was 0.9 percent of inventory or 26 board feet per acre per year. A 5-percent mortality rate for elm, the highest of any species group, can be primarily attributed to Dutch elm disease.

FIA field crews could not attribute 5.1 million cubic feet (32 percent) of growing-stock mortality to any particular causal agent. Of the 11.0 million cubic feet of mortality for which a cause was noted, the major reasons for death were disease (47 percent), weather (32 percent), and suppression (7 percent).

CURRENT REMOVALS HALF OF 1973 REMOVALS

Current annual growing-stock removals dropped 51 percent from 50.3 million cubic feet in 1973 to 24.7 million cubic feet in 1988. Average annual removals during the period 1974 to 1989 were 24.1 million cubic feet. Current annual sawtimber removals declined from 163.3 to 94.6 million board feet from 1973 to 1988 (fig. 20). Average annual sawtimber removals over the period 1974 to 1989 amounted to 90.4 million board feet. Three components comprise total removals: timber products, logging residues, and other removals. Other removals refers to growing-stock trees that were removed but not used for products, as in the case of land clearing, as well as trees removed from the timberland classification because of a change in land use.

The other removals component, which declined by nearly 70 percent from 1973 to 1988, is the major reason for the decline in total removals. Several factors contributed to this decline. Other removals reported in 1973 was high because of land conversion, as timberland was cleared for agricultural crops, primarily corn and soybeans, or for grazing. Grazing contributed to the other removals component even when trees were not cut, as timberland was reclassified to wooded pasture, a nontimberland category. Declines in the farm and livestock economies since 1973 have drastically reduced these types of losses to the remaining timberland base.

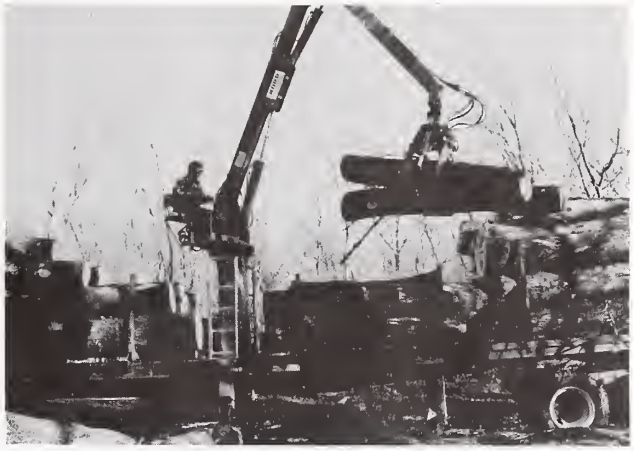

Figure 20.—*Loading hardwood logs from an Iowa woodlot onto a truck for transport to a mill. Sawtimber removals in 1988 were 42 percent less than in 1974.*

Removals for timber products and other removals each accounted for 45 percent of 1988 removals, and logging residues made up the remaining 10 percent (fig. 21). Removals for products declined by 15 percent (2.0 million cubic feet) overall, although saw-log removals increased from 7.2 to 8.8 million cubic feet (23 percent), accounting for 79 percent of all product removals in 1988. Fuelwood removals declined by 68 percent, from 3.1 million cubic feet in 1973 to 1.0 million cubic feet in 1988, as demand for fuelwood slowed. Together, red oak, white oak, and cottonwood accounted for 60 percent of total removals and 72 percent of product removals.

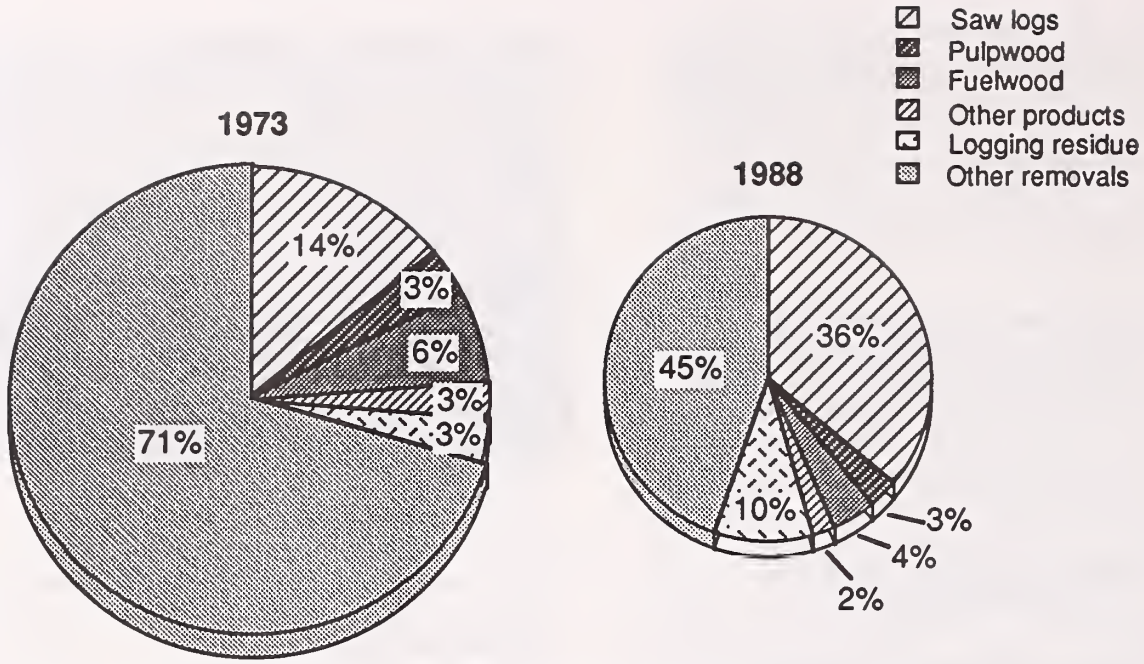

Figure 21.—*Current annual removals of growing stock on timberland by item, Iowa, 1973 and 1988.*

Average annual removals of growing stock amounted to 55 percent of average net annual growth during the period 1974 to 1989. Removals for select white oaks and select red oaks equaled 95 and 75 percent of growth, respectively (fig. 22). Removals of hard maple (black and sugar maple), a slow-growing but valuable species group, exceeded growth by 10 percent. Hard hardwoods[6], primarily oak and hickory, made up 53 percent of growing-stock removals compared to 46 percent of soft hardwoods (primarily soft maple, cottonwood, and elm) and 1 percent of softwoods (primarily eastern redcedar).

Average annual sawtimber removals made up only 46 percent of sawtimber average annual growth in 1974 to 1989.

NEARLY THREE-QUARTERS OF BIOMASS IS IN TREE BOLES

Biomass is a measure of the weight of living vegetation per unit of area. Although growing-stock volume and potential site productivity provide valuable information to those interested in timber production, biomass is a more inclusive measure of site productivity. For

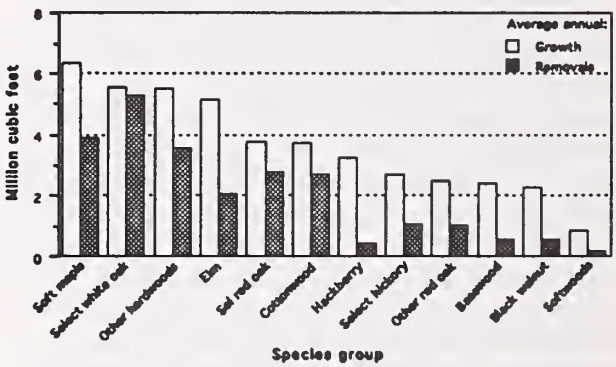

Figure 22.—*Average net annual growth and average annual removals by species group, Iowa, 1974-1989.*

example, ecologists estimate annual production, accumulation, and distribution of biomass to describe and compare terrestrial ecosystems. FIA estimates of biomass do not include foliage or belowground components of plants and trees.

Total aboveground biomass of all live trees greater than 1 inch d.b.h. was 136 million tons green weight, an average of 70 tons per acre. This compares to 73 tons per acre in Illinois, 64 in Missouri, and 60 in Minnesota. Hardwood forest type averages ranged from 59 tons per acre for the maple-basswood type to 113 tons per acre for the cottonwood-aspen type.

[6] *Hard hardwoods are species having an average specific gravity greater than or equal to 0.50.*

Nine percent of all live tree biomass is in trees from 1 to 5 inches d.b.h. (fig. 23). Of live trees greater than 5 inches, 73 percent of the biomass (90.1 million tons) is found in the bole, from 1 foot above the ground to a 4-inch top diameter. Tops and limbs make up another 21 percent, and stumps contain 6 percent. Fifty-five percent of all live tree biomass is in growing-stock trees, and 36 percent is in nongrowing-stock trees (rough and rotten trees).

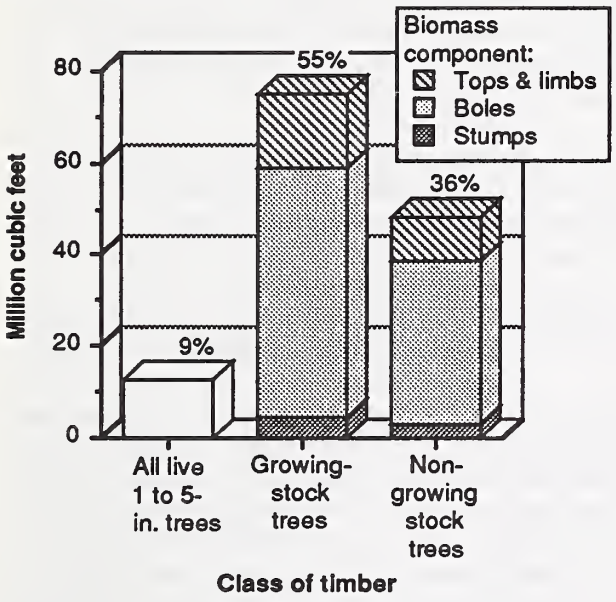

Figure 23.—*Distribution of all live tree biomass on timberland by biomass component.*

Shrubs and tree seedlings contribute an additional 0.9 million tons or 0.5 tons per acre of biomass. Tree seedlings make up 60 percent of this total, tall shrubs account for 28 percent, and low shrubs make up the remaining 12 percent. The cottonwood-aspen forest type supports the largest tree seedling and shrub biomass (2,537 pounds per acre), consisting almost entirely of prickly ash. This is followed by the bur oak (1,541 pounds per acre), eastern redcedar-hardwood (1,302 pounds per acre), and maple-basswood (1,189 pounds per acre) forest types. Prickly ash, among the shrubs; and eastern hophornbeam, eastern redcedar, select red oak, hard maple, and elm, among tree seedlings; contribute the greatest biomass in these types.

Among tree seedlings, elm has the greatest average biomass per acre (100 pounds per acre green weight)[7], followed by hard maple (66 pounds per acre). Prickly ash contributes the most biomass (160 pounds per acre) among tall shrubs, while Virginia creeper produces the greatest biomass of the low shrubs (38 pounds per acre).

RECREATION AND WILDLIFE ARE IMPORTANT FOREST RESOURCES

Although Iowa's forests are a small percentage of the land surface and are mostly held by private owners, outdoor recreation use is a cherished benefit. According to the Iowa Department of Natural Resources, more than 12 million visits occur annually on the 630,000 acres of Iowa's public land and water recreational areas developed for activities such as fishing, camping, hiking, picnicking, and general relaxation (fig. 24). Public recreational areas in Iowa are well distributed throughout the State and are easily accessible. Presently, State recreation areas are in a phase of facilities improvement, trail development, and limited land acquisition. In addition, dispersed recreation activities such as fishing and hunting occur frequently on both public and private areas (with permission) every year, according to the 1990 Iowa Park User Survey.

In many areas of the State, blocks of forested lands are linked by wooded corridors, such as rivers and streams, abandoned railroad rights-of-way, and wooded strips. Wooded corridors are important forest resources for recreation use, and have the added benefit of facilitating the movement of people and animals between forested blocks.

Iowa's forests are a source of food and shelter for wildlife; and the mix of trees, shrubs, forbs, and grasses increases wildlife diversity. For instance, many species of forest game animals, such as squirrels, deer, and wild turkey, rely on acorns for part of their food supply. Walnut and hickory nuts are also important sources of food for some wildlife,

[7] *A weighted average based on the number of plots sampled in each forest type and the biomass of each seedling species in the type, including types in which the seedling species was not found.*

Figure 24.—*This meandering forest road through the Shimek State Forest in southeast Iowa offers a relaxing vista to world-weary visitors.*

and browse is important food for deer. Much of the acreage that converted from pasture to timberland between inventories is classed as the maple-basswood type (table 1). Species in that type, such as sugar maple and basswood, can reproduce through sprouting and root suckering, and can produce large quantities of browse for deer. In 1991, the year after the Iowa inventory, 83,000 deer and 14,500 cottontail rabbits were taken by hunters, who purchased 127,753 resident hunting licenses, 45,882 nonresident hunting licenses, and 82,060 combination hunting and fishing licenses (these and other following recreation and wildlife statistics were provided by the Iowa Department of Natural Resources).

The conversion of pasture to timberland, and the increased interest in restoring marginal farm land to permanent vegetative cover have also increased the amount of cover for upland game birds, such as sharp-tailed grouse, bobwhite quail, and pheasants. The tree seedlings and shrubs that move into these areas, such as sumac, snowberry, dogwood, and hazel, and the edge effect they furnish when adjacent to cultivated fields, provide excellent habitat for game birds and other wildlife. In some areas of the State, the increased population of upland game birds, especially pheasants, has fostered a "cottage industry" where landowners lease land to hunters or provide "hunting packages" that include overnight bed and breakfast services. Although much of the hunting is done on private land, a total of 388,000 acres of public land is available for hunting in the State. In 1991, more than 1.2 million pheasants were taken in Iowa by hunters.

The availability of habitat and the abundance of wildlife in the State increase recreational opportunities for both consumptive and nonconsumptive users of Iowa's forest.

WOOD-USING INDUSTRIES IMPORTANT TO STATE'S ECONOMY

Although small in comparison to the contributions of the agricultural sector to the State's economy, the contributions of the wood-using sector are important. According to the U.S. Department of Commerce (1990), there were 174 working establishments in Iowa in the lumber and wood products[8] industry in 1987 (Standard Industrial Classification Code 24), which employed a total of 6,000 persons with a yearly payroll of $125.7 million dollars. Many of these establishments were small—140 of them had fewer than 20 employees. In 1977, there were also 174 such establishments with a total work force of 5,200 persons and a payroll of $57.8 million (U.S. Department of Commerce 1980).

Value added by manufacture, by identifying the amount of money added to the economy by the harvesting and processing of the raw material, is another yardstick in evaluating the economic impact of an industry. The lumber and wood products industry generated $287.7 million of value added in 1987, compared with $124.5 million in 1977.

[8] *Lumber and wood products industries include sawmills, planing mills, millwork, and manufacturers of plywood, wood containers (includes pallets), wood buildings, and mobile homes.*

Capital expenditures on plant and equipment—an expression of industry's confidence in the future—is another basis for comparison. In 1987 new capital expenditures in the lumber and wood products industry in Iowa amounted to $19.1 million, compared to $9.3 million in 1977.

TIMBER SUPPLY PROJECTED TO EXPAND

To better understand the future timber resource of Iowa and its role in providing for the wood needs of the State and Nation, we made two sets of 30-year projections of the State's growing-stock timber situation. One projection assumes that timber removals will increase modestly (the low removals option), even though 1988 removals were only half of 1973 removals. This reversal of the trend is based on the assumption that the other removals component, which accounted for 71 percent of the 1973 removals and for 45 percent of the 1988 removals, will continue to decline further as land clearing slows. It is further based on the increase in saw-log production between inventories, and the assumption that future demand will be high for mature, high quality hardwoods in Iowa. The other projection assumes a higher level of timber removals (the high removals option) and a somewhat more robust market for timber products. Softwoods and hardwoods were projected together because softwoods represent such a small part of the total resource.

Assumptions common to both projections are: (1) the total area of timberland will decline an average of 0.63 percent per year between 1990 and 2020, from 1,944 thousand acres to 1,577 thousand. This also reverses the trend between 1974 and 1990 when timberland area increased 33 percent, and is based on trends established by Wall (1981). Most of that increase resulted from the conversion of improved pasture and wooded pasture to timberland, and we assumed that land conversion on this scale will not occur in the near future. (2) The intensity of management will increase slightly over time. (3) Average growth rates will decline slightly, from 3.1 percent in 1989 to 2.8 percent in 2020, although the volume of growth produced will continue to increase for the low option and will remain virtually constant for the high option.

Low Removals Option Projection

In the low removals option projection for growing stock, timber removals rise continuously from 24.7 million cubic feet in 1988 to 31.9 million cubic feet in 2020, a 29-percent increase. Growth remains substantially higher than removals throughout the period, and the difference between growth and removals widens slightly each year. The inventory of growing stock rises briskly during the entire 30-year period, but at a slightly lower rate each decade (fig. 25).

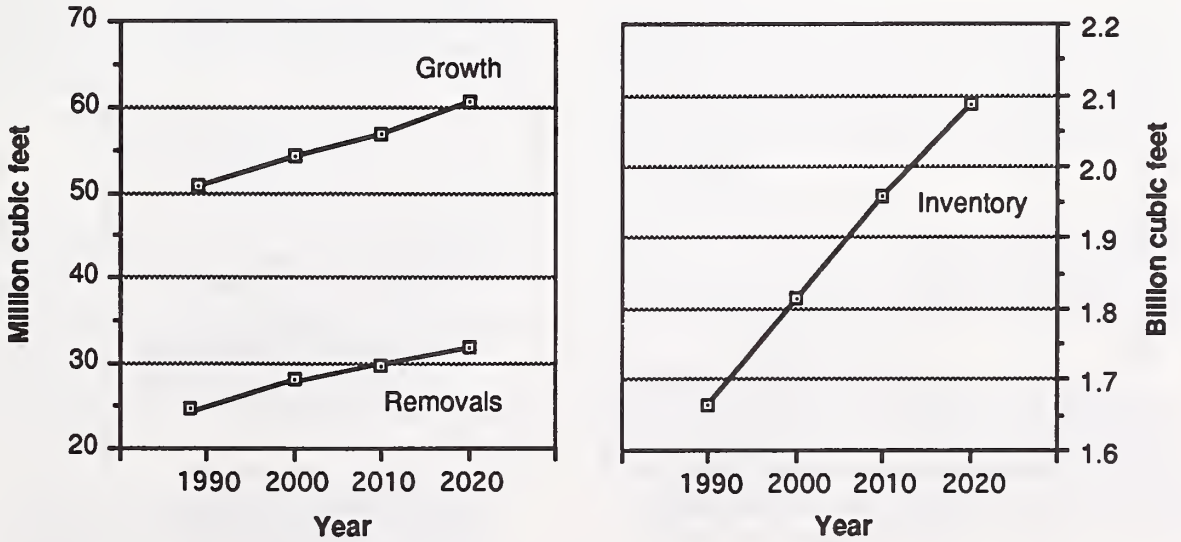

Figure 25.—*Net annual growth, annual timber removals, and inventory of growing stock on timberland in Iowa, 1990, and low removals option projections to 2020.*

Net annual growth of growing stock is projected to increase from 50.9 million cubic feet in 1989 to 60.5 million in 2020, a 19-percent gain. Net annual growth per acre is projected to rise during the period also.

The inventory of growing stock is projected to expand from 1.7 billion cubic feet in 1990 to 2.1 billion in 2020, a 25-percent gain. The rate of increase slows from 9 percent in the first decade to 8 percent in the second decade and 7 percent in the third decade of the period.

High Removals Option Projection

Removals are projected to rise from 24.7 million cubic feet in 1988 to 39.2 million in 2020, a 59-percent gain. Growth remains greater than removals throughout the period, but levels out in the second decade and declines during the third decade, shrinking the surplus of growth over removals. The inventory of growing stock increases, but at a decreasing rate, until by 2020 it is almost flat (fig. 26).

Growth is projected to rise from 50.9 million cubic feet in 1989 to 52.8 million in 2000, and then fall off to 51.3 million in 2020, for a net gain of 1 percent. At the beginning of the period, growth is projected to exceed removals by 26.2 million cubic feet; but by the end of the period, this surplus is cut to 12.1 million cubic feet.

Growing-stock inventory is projected to increase by only 10 percent, from 1.7 billion cubic feet in 1990 to 1.8 billion in 2020. The 6-percent rate of increase for the first decade is projected to slow to 3 percent in the second decade and to 1 percent in the final decade, as growth and removals approach one another.

THE OUTLOOK

Our low and high removals option projections will portray the future accurately only if the assumptions upon which they are based are sound. The projections probably represent the high and low limits of the future forest situation. Projections made for the first decade are more dependable than those for the last two decades because economic and market conditions can shift rapidly, eroding the reliability of long-range projections.

Growing-stock inventory will likely continue to build until 2020. This continuing expansion will result as trees on existing timberland grow to larger diameter classes, and as net growth accrues faster than timber removals. Intensified forest management, if applied over broad areas, will yield higher inventory levels than those projected by harvesting trees before they die of natural causes and by creating more favorable conditions for tree growth to accelerate.

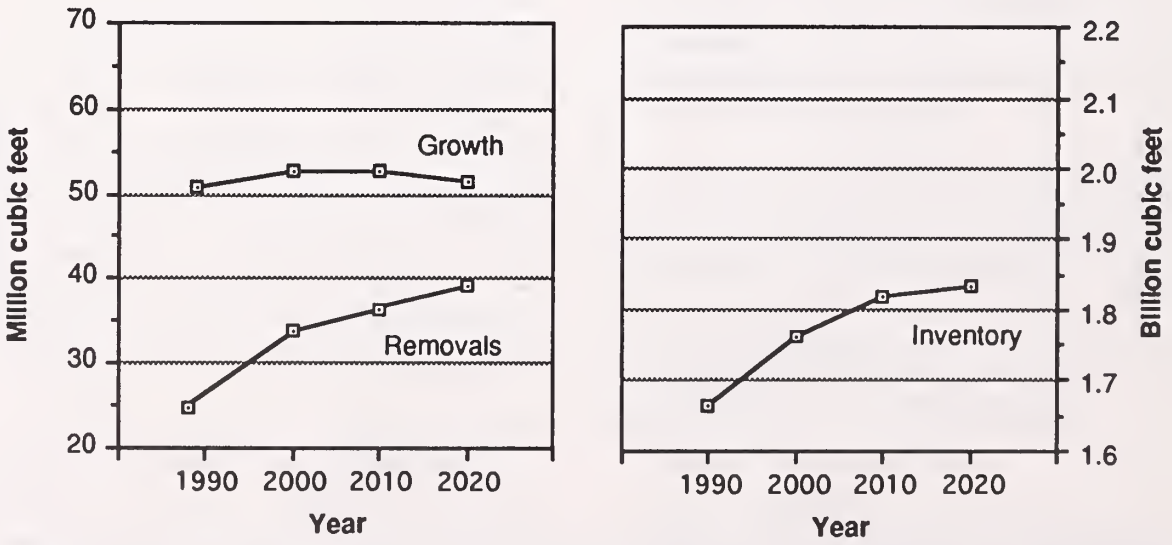

Figure 26.—*Net annual growth, annual timber removals, and inventory of growing stock on timberland in Iowa, 1990, and high removals option projections to 2020.*

The inventory of growing stock can be extended further if more nongrowing-stock material can be used, taking some of the pressure off growing stock to provide timber removals. Residues, tree tops and limbs, and short-log and rough and rotten trees are part of the nongrowing-stock inventory, for which greater use may be found. As mentioned earlier, the ratio of rough and short-log tree volume to growing-stock volume in the State is very high, and reducing this ratio will benefit growing-stock inventory.

The inventory of oaks will continue to eclipse that of other species, but inventories of hackberry, eastern redcedar, black cherry, black walnut, hickory, and basswood—although comparatively small—are expanding rapidly. Some of these species have been utilized little in the past, and ways to use them in the future will need to be explored.

Demand for large diameter, high-quality oak saw logs from both domestic and international markets will remain high, especially for red oak. Care will need to be taken to ensure that the quality and productivity of the oak resource remain high, despite this strong demand.

The public's awareness of environmental problems and its perception of solutions to them will help sculpt Iowa's future forests. Forest management strategies that are ecosystem-sensitive and that enhance the noncommodity products of the forest, such as recreation, clean water, and wildlife, will become more operational as timber industry interests seek to find common ground with environmental interests.

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APPENDIX

ACCURACY OF THE SURVEY

The Forest Inventory and Analysis sampling procedure is designed to provide reliable statistics at the State and Survey Unit levels. Because the inventory is a sample of Iowa's forests, the reported figures are estimates. Sampling errors reflect the reliability of these estimates. From sampling errors we can compute, for a specified probability, the range of values likely from a 100-percent inventory, provided the same methods were used in that inventory. Sampling errors for the Forest Survey Unit and county totals of volume, average net annual growth, average annual removals, and area of timberland for the 1990 Iowa inventory are shown in table 30.

For example, the estimated growing-stock volume in Iowa in 1990—1,663 million cubic feet—has a sampling error of ± 3.24 percent (± 53.9 million cubic feet). The growing-stock volume from a 100-percent inventory would be expected to fall between 1,609 and 1,717 million cubic feet (1,663 ± 53.9), there being a one in three chance that this is not so.

The following tabulation shows the sampling errors for the 1990 Iowa inventory:

Item	State totals	Sampling error
Growing stock	(Million cubic feet)	(Percent)
Volume (1990)	1,663.0	3.24
Average annual growth (1974-1989)	44.0	5.02
Average annual removals (1974-1989)	24.1	9.11
Sawtimber	(Million board feet)	
Volume (1990)	5,768.2	3.90
Average annual growth (1974-1989)	196.9	5.61
Average annual removals (1974-1989)	90.4	9.67
Timberland	(Thousand acres)	
Area (1990)	1,943.5	1.92

Breaking survey data down into sections smaller than State totals increases the sampling error (fig. 27). When the estimated area, volume, or growth is half the State total, the sampling error is about 1.4 times as large as the sampling error listed in the previous tabulation. The multiplier increases rapidly for smaller fractions, however; estimates that are only one-tenth of the State total have sampling errors more than three times the statewide sampling error. To estimate sampling error for data smaller than State totals, use the formula below:

$$E = \frac{(SE)\sqrt{\text{(State total area or volume)}}}{\sqrt{\text{(Volume or area smaller than State total)}}}$$

where:

E = sampling error in percent

SE = State total error for area or volume

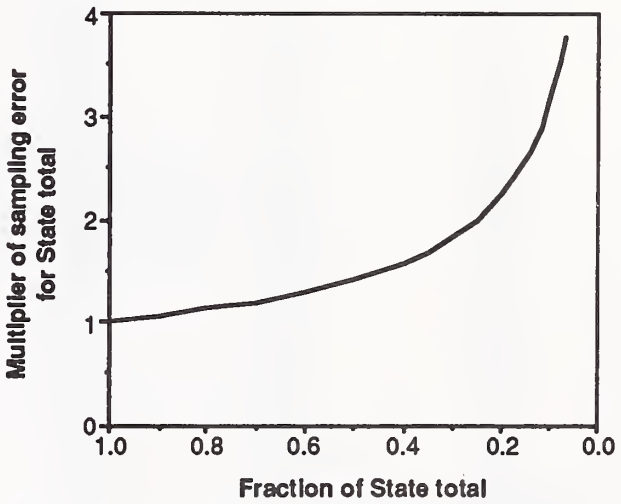

Figure 27.—*Relation between sampling error and estimates smaller than State totals.*

For example, to compute the error on the area of timberland in the elm-ash-soft maple type in the State, proceed as follows:

The total area of elm-ash-soft maple type in the State from table 5 = 472,900 acres.

The total area of timberland in the State from table 5 = 1,943,500 acres.

The State total error for timberland area from the above tabulation = 1.92 percent.

Using the above formula:

$$Error = \frac{(1.92)\sqrt{1,943,500}}{\sqrt{472,900}}$$

$$= \pm 3.89 \text{ percent}$$

SURVEY PROCEDURES

The 1990 Iowa survey used a growth model-enhanced, two-phase remeasurement sample design. This sampling scheme and associated estimators are similar to the design used at the Pacific Northwest Forest and Range Experiment Station in the inventory of eastern Washington and Oregon (MacLean 1981). With this design, field crews revisit every plot measured in the previous inventory. On some plots (remeasurement plots), they take all measurements. On other plots (status-check plots), field crews only record tree status (live, cut, or dead) and merchantability (growing stock, rough, or rotten). For both types of plots, they measure trees that have grown onto the plot since the last inventory. New plots were added to the sample to replace plots that had been measured in 1974 but could not be relocated. New photo plots were also added to sample reserved forest lands.

The Iowa design differs from the eastern Washington and Oregon design because it uses a growth model to improve regression estimates made on status-check plots. Figure 28 presents a graphical overview of the Iowa sample design. The growth model used in the Iowa survey design was the Central States Stand and Tree Evaluation and Modeling System (STEMS) (Shifley 1987).

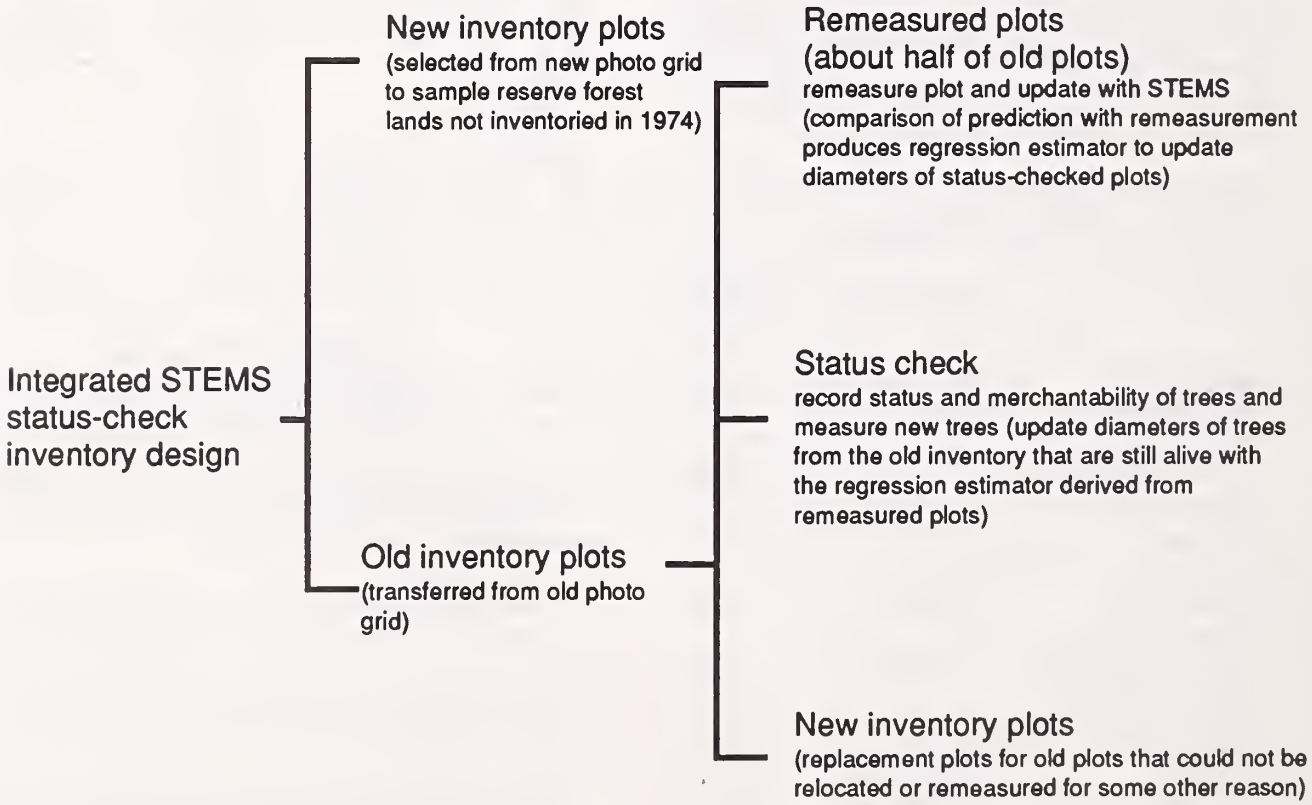

Figure 28.—*Overview of the Iowa sample design.*

These were the major steps in the 1990 Iowa survey design:

1. Aerial photography (Phase 1)

In this phase, ground plot locations from the 1974 inventory were relocated on new photographs. The USDA Agricultural Stabilization and Conservation Service provided 1:40,000 scale black and white prints. Photographs were taken in the following years:

Unit & County	Year	Unit & County	Year	Unit & County	Year
Northeastern Unit		Hamilton	1980	Cerro Gordo	1980
Allamakee	1979	Hardin	1980	Cherokee	1977
Benton	1978	Henry	1978	Clay	1978
Black Hawk	1979	Iowa	1979	Crawford	1977
Bremer	1979	Jasper	1982	Dickinson	1978
Buchanan	1979	Jefferson	1978	Emmet	1981
Butler	1980	Keokuk	1978	Franklin	1978
Cedar	1979	Lee	1978	Fremont	1981
Chickasaw	1979	Louisa	1978	Greene	1981
Clayton	1979	Lucas	1977	Hancock	1980
Clinton	1979	Madison	1982	Harrison	1981
Delaware	1979	Mahaska	1978	Humboldt	1980
Dubuque	1979	Marion	1982	Ida	1977
Fayette	1979	Marshall	1980	Kossuth	1980
Floyd	1979	Monroe	1977	Lyon	1978
Grundy	1980	Muscatine	1978	Mills	1978
Howard	1979	Polk	1982	Monona	1981
Jackson	1979	Poweshiek	1979	Montgomery	1979
Johnson	1979	Story	1980	O'Brien	1978
Jones	1979	Van Buren	1978	Osceola	1978
Linn	1979	Wapello	1978	Page	1981
Mitchell	1980	Warren	1982	Palo Alto	1981
Scott	1978	Washington	1978	Plymouth	1978
Tama	1980	Wayne	1977	Pocahontas	1981
Winneshiek	1979	Webster	1981	Pottawattamie	1981
Southeastern Unit		Western Unit		Ringgold	1981
Appanoose	1977	Adair	1982	Sac	1977
Boone	1980	Adams	1974	Shelby	1977
Clarke	1982	Audubon	1977	Sioux	1979
Dallas	1977	Buena Vista	1978	Taylor	1980
Davis	1978	Calhoun	1981	Union	1982
Decatur	1977	Carroll	1978	Winnebago	1980
Des Moines	1978	Cass	1982	Woodbury	1981
Guthrie	1982	Worth	1980	Wright	1980

Aerial photogrammetrists assembled the photographs into township mosaics and overlaid a systematic grid of 121 1-acre photo plots (each plot representing approximately 190.4 acres) on each township mosaic. They then stereoscopically examined each photo plot and classified it based on land use. If trees were present, forest type and stand-size density class were recorded. All of the 1974 ground plot locations were sent to the field for verification of the photo classification and for further measurements. In addition, one-fifth of the new photo plots on reserved forest lands were selected as ground plots because these areas had been excluded from the 1974 inventory. The 201,969 photo plots were classified in the following way:

Photo land class	Photo plots
Timberland	11,529
Reserved forest land	373
Unproductive forest land	1
Other forest land	8
Questionable	195
Nonforest with trees	3,059
Nonforest without trees	185,020
Water	1,784
All classes	201,969

2. Plot measurements (Phase 2)

Field crews revisited all old ground plots. Each old ground plot that could not be relocated was replaced with a new plot at the approximate location of the old one. Each plot is a cluster of 10 points covering approximately 1 acre. At each point, trees 5 inches or more in d.b.h. were sampled on a 37.5 basal area factor (BAF) variable-radius plot, and trees less than 5 inches d.b.h. were sampled on a 1/300-acre fixed-radius plot.

On approximately one-half the plots (the status-check plots), a partial set of items—tree history (status and merchantability) and cause of death (if the tree had died)—was tallied on trees measured at the 1974 inventory. New trees on the status-check plots and all trees on the remaining plots had the complete set of items tallied. Some plots originally selected as status-check plots became full measurement plots to ensure that sufficient plots containing high-valued minor species such as black walnut and butternut were remeasured.

Plots with the complete set of items tallied were projected from the 1974 inventory to the current time using STEMS. The procedure provides a comparison between measured and projected tree diameters for about half the trees. Adjustment factors (a modification of the method described by Smith 1983), computed from the comparison of the observed and projected diameters, provide a local calibration of the STEMS model to conditions existing from 1974 to 1990. The adjusted model was used to project the 1974 diameters of trees on the status-check plots. Projected diameters of trees on the status-check plots were summarized as if they had been measured in the field. Because all trees that had died or had been cut since 1974 were recorded, mortality and removals did not need to be projected for any plots. Ground plots were distributed as follows:

Ground land use class	Old plots remeasured	Old plots with status check	New plots	Total plots
Timberland	397	222	7	626
Reserved forest land	3	4	74	81
Other forest land	4	2	0	6
Nonforest with trees	153	11	1	165
Nonforest without trees	11,705	17	65	11,787
Water	86	1	17	104
Total	12,348	257	164	12,769

3. Area estimates

Area estimates were made using two-phase estimation methods. With this method, a preliminary estimate of area by land use is made from the aerial photographs (Phase 1) and corrected by the plot measurements (Phase 2). Loetsch and Haller (1964) present a complete description of the method.

4. Volume estimates

Hahn and Hansen (1991) developed the net cubic foot volume equations used to compute the volume of trees measured or modeled on the 10-point plots. The summed tree volumes provide estimates of volume per acre for each ground plot. Estimates of volume per acre were multiplied by the area estimates to obtain estimates of total volume.

The Forest Service reports all board foot volume in International 1/4-inch rule. In Iowa, both the Doyle and Scribner log rules are commonly used. Doyle log rule conversion factors were derived from full tree measurements taken throughout the Central States (Illinois, Indiana, Iowa, and Missouri), and Scribner log rule conversion factors were derived from full tree measurements taken throughout the Lake States (Michigan, Wisconsin, and Minnesota). The full tree measurements were used in an equation developed by Wiant and Castenaeda (1974) to produce the factors (multipliers) listed below that were used to convert board foot International volumes to the Doyle or Scribner rule.

5. Growth and mortality estimates

Estimates of growth and mortality per acre come from the remeasured and projected diameters of trees and from observation of trees that died between inventories. Growth is reported as the average net annual growth between the two inventories (1974 and 1990) and computed from data on remeasurement plots and modeled plots using methods presented by VanDeusen *et al.* (1986). Mortality is also average net annual for the remeasurement period. On new plots, where trees were not remeasured, estimates of growth and mortality were obtained by using STEMS to project the growth and mortality of trees for 1 year. Growth on status check plots was estimated using the projected tree diameters obtained from the STEMS growth model. The STEMS growth model was adjusted to Iowa conditions using data from the remeasurement plots. As with volume, total growth and mortality estimates were obtained by multiplying the per acre estimates by area estimates. Current annual growth for 1990 was computed by using the adjusted STEMS model to grow all current inventory plots for 1 year.

D.B.H.	Doyle rule conversion factor		Scribner rule conversion factor	
(inches)	Softwoods	Hardwoods	Softwoods	Hardwoods
9.0-10.9	0.3455	—	0.7830	—
11.0-12.9	.4780	0.4172	.8287	0.8317
13.0-14.9	.5992	.5118	.8577	.8611
15.0-16.9	.6908	.5882	.8784	.8827
17.0-18.9	.7685	.6569	.8945	.8999
19.0-20.9	.8573	.7180	.9079	.9132
21.0-22.9	.8645	.7829	.9168	.9239
23.0-24.9	.9276	.8324	.9240	.9325
25.0-26.9	.9493	.8736	.9299	.9396
27.0-28.9	.9710	.9473	.9321	.9454
29.0+	1.1065	1.1349	.9357	.9544

6. Average annual removals estimates

Average annual growing-stock and sawtimber removals (1974 to 1990) were estimated from the remeasured and status-check plots. These estimates are obtained from trees measured in the last survey and cut or otherwise removed from the timberland base.

7. Timber removals, utilization, and timber product output estimates

Statistics on timber product output during 1988 came from a canvass of known primary wood-using mills that consume Iowa bolts and logs. Iowa Department of Natural Resources (DNR) foresters canvassed the mills in Iowa. The North Central Forest Experiment Station (NCFES) mailed a similar questionnaire to all out-of-State mills that use Iowa roundwood.

Logging utilization factors were used to estimate the logging residue. These factors were determined from logging utilization studies conducted between 1984 and 1987 in the Central States by NCFES and deemed suitable for estimating timber removals in Iowa.

Residential fuelwood and fence post statistics were developed for Iowa based on data from the Bureau of Census 1980 population figures, preliminary species volume distribution data from the 1990 Iowa survey, and harvesting patterns and species preference from recent fuelwood studies in Illinois (1983) and Missouri (1987). Harvest patterns and individual species preferences for areas of similar population density were mapped onto current inventory data to develop fuelwood harvest distributions by species preferences. A similar process was used to estimate post production. Detailed information about removals, utilization, and outputs can be found in Smith and Tibben (1990).

Because all primary wood-using mills were canvassed, there is no sampling error associated with roundwood products or the wood and bark residue generated from these products. Fuelwood and post data are estimated to have an error of about ± 15 percent at the State level.

COMPARING IOWA'S THIRD INVENTORY WITH THE SECOND INVENTORY

The following paragraphs highlight some procedural changes since the last inventory to help readers analyze data from this report:

New volume equations developed for the Central States (see Survey Procedures section) were used to compute the 1990 volumes and to recompute the 1974 volume. Although the adjustment will differ by Survey Unit and species, the recomputed 1974 growing-stock and board foot volumes are generally greater than those shown in the 1974 report.

Mortality figures published in the 1974 inventory report were based on field estimates of the number of trees that died in the 3 years before the inventory. Information gathered on remeasurement plots during the current inventory was used to adjust the 1974 mortality figures. This adjustment also will affect the estimate of net growth for the 1974 inventory.

The previous survey used only growing-stock trees to determine stand-size class. Current survey procedures require that stand-size class be determined by all live trees. Therefore, direct comparisons of current inventory data to the published 1974 data by stand-size class may be misleading.

Forest typing has changed since the 1974 survey. Compared to those of 1974, current methods require that stands contain a larger proportion of bur oak, the white oaks, or cottonwood to be classed as bur oak, white oak, or cottonwood forest type, respectively. Therefore, 1974 forest types have been reclassified using the 1990 methods.

Potential productivity is generally greater when current methods are applied to the previous inventory than the methods used to compile the 1974 report. Therefore, comparisons of the potential productivity in 1974 and 1990 may be misleading.

TREE/LOG GRADE

In Iowa the butt section of every sawtimber sample tree was graded for quality on approximately one-half of the sample plots (remeasured and new plots). The volume yield by tree/log grade for species in this sample was used to distribute the volume of trees in the ungraded sample into tree/log-grade classes by species group.

Grading specifications used by the field crews are presented in the following tables. Hardwood sawtimber trees were graded according to "Hardwood tree grades for factory lumber" (Hanks 1976) unless minimum specifications for grade 3 were not met. In those cases, a grade 4 was assigned according to "Forest Service standard specifications for hardwood construction logs" (Rast *et al.* 1973). White pine sawtimber trees were graded according to the table "Log grades for eastern white pine" (Campbell 1964). The table "Log grades for all other softwoods" (Peterson 1965) provides grading criteria for other softwood sawtimber trees. For all softwoods, the first 16-foot log, or shorter lengths down to 12 feet, were used for grading.

HARDWOOD TREE GRADES FOR FACTORY LUMBER

Grade factor	Tree grade 1	Tree grade 2	Tree grade 3
Length of grading zone (feet)	Butt 16	Butt 16	Butt 16
Length of grading section [a] (feet)	Best 12	Best 12	Best 12
DBH, minimum (inches)	16[b]	13	11
Diameter, minimum inside bark at top of grading section (inches)	13[b] 16 20	11[c] 12	8
Clear cuttings (on the 3 best faces)[d]			
Length, minimum (feet)	7 5 3	3 3	2
Number on face (maximum)	2	2 3	[e]
Yield in face length (minimum)	5/6	4/6	3/6
Cull deduction (including crook and sweep, but excluding shake) maximum within grading section (percent)	9	9[f]	50

[a] Whenever a 14- or 16-foot section of the butt 16-foot log is better than the best 12-foot section, the grade of the longer section will become the grade of the tree. This longer section, when used, is the basis for determining the grading factors such as diameter and cull deduction.

[b] In basswood and ash, DIB at top of grading section must be 12 inches and DBH must be 15 inches.

[c] Grade 2 trees can be 10 inches DIB at top of grading section if otherwise meeting surface requirements for small grade 1's.

[d] A clear cutting is a portion of a face free of defects, extending the width of the face. A face is one-fourth of the surface of the grading section as divided lengthwise.

[e] Unlimited.

[f] Fifteen percent crook and sweep or 40 percent total cull deduction are permitted in grade 2, if size and surface of grading section qualify as grade 1. If rot shortens the required clear cuttings to the extent of dropping the butt log to grade 2, do not drop the tree's grade to 3 unless the cull deduction for rot is greater than 40 percent.

Forest Service standard specifications for hardwood construction logs (tie and timber logs)[1]

Position in tree	Butts and uppers
Min. diameter, small end	8 inches +
Min. length without trim	8 feet
Clear cuttings	No requirements
Sweep allowance	One-fourth of the diameter at the small end for each 8 feet of length.
Sound surface defects:	
Single knots	Any number, if no one knot has an average diameter above the callus in excess of one-third of the log diameter at point of occurrence.
Whorled knots	Any number, if the sum of knot diameters above the callus does not exceed one-third of the log diameter at point of occurrence.
Holes	Any number, provided none has a diameter over one-third of the log diameter at point of occurrence and none extends more than 3 inches into included timber[2].
Unsound surface defects :	Same requirements as for sound defects if they extend into included timber. No limit if they do not.

[1]These specifications are minimum for the class. If, from a group of logs, factory logs are selected first, thus leaving only nonfactory logs from which to select construction logs, then the quality range of the construction logs so selected is limited, and the class may be considered a grade. If selection for construction logs is given first priority, it may be necessary to subdivide the class into grades.

[2] Included timber is always square, and dimension is judged from small end.

LOG GRADES FOR EASTERN WHITE PINE

Log grade	Minimum size [1] Diameter *(Inches)*	Length *(Feet)*	Sweep or crook allowance *(Percent)*	Total cull allowance including sweep *(Percent)*	Maximum weevil injury *(Number)*	Allowable knot size(inches)[2] on three best faces or minimum clearness on four faces *(Inches)*
1	12 & 13	8-16	20	50	0	Four faces clear full length
	14+	10-16	20	50	0	Two faces clear full length, or four faces clear 50 percent length (6 feet min. length)[3]
2	6+	8-16	30	50	0	Sound knots ≤[4] D/6 and less than 3 inches[5] Unsound knots: ≤1-1/2 inches and for: butt, logs ≤ D/12 upper logs ≤ D/10, or four faces clear 50 percent of length
3	6+	8-16	40	50	8-foot logs: 1 weevil 10-foot+ logs: 2 weevils	Sound knots ≤ D/3 and less than 5 inches Unsound knots ≤ D/6 and less than 2-1/2 inches
4	6+	8-16	50	50	No limit	No limit

[1] *Plus trim.*

[2] *Disregard all knots less than 1/2-inch diameter in all grades.*

[3] *The sum of the diameter of sound knots plus twice the sum of the diameter of unsound knots (in inches) is less than or equal to half of the diameter of the log (inches).*

[4] *≤ means less than or equal to.*

[5] *D means d.i.b. of log at location of knot.*

LOG GRADES FOR ALL OTHER SOFTWOOD LOGS

Grade 1

1. Logs must be 16 inches in diameter or larger, 10 feet in length or longer, and with deduction for defect not over 30 percent of gross scale.

2. Logs must be at least 75 percent clear on each of three faces.

3. All knots outside clear cutting must be sound and not more than 2-1/2 inches in size.

Grade 2

1. Logs must be 12 inches in diameter or larger, 10 feet in length or longer, and with a net scale after deduction for defect of at least 50 percent of the gross scale deducted for defect.

2. Logs must be at least 50 percent clear on each of three faces or 75 percent clear on two faces.

Grade 3

1. Logs must be 6 inches in diameter or larger, 8 feet in length or longer, and with a net scale after deduction for defect of at least 50 percent of the gross contents of the log.

Note: A) Diameters are diameter inside bark (d.i.b.) at small end of log.
B) Percent clear refers to percent clear in one continuous section.

METRIC EQUIVALENTS OF UNITS USED IN THIS REPORT

1 acre = 4,046.86 square meters or 0.405 hectare
1,000 acres = 405 hectares
1 cubic foot = 0.0283 cubic meter
1 foot = 30.48 centimeters or 0.3048 meter
1 inch = 25.4 millimeters, 2.54 centimeters, or 0.0254 meter
1 pound = 0.454 kilograms
1 ton = 0.907 metric tons

TREE SPECIES GROUPS IN IOWA[9]

SOFTWOODS		**Abundance[10]**
Eastern redcedar	*Juniperus virginiana*	c
Other softwoods		
Red pine	*Pinus resinosa*	vr
Eastern white pine	*Pinus strobus*	vr
White spruce	*Picea glauca*	vr
Balsam fir	*Abies balsamea*	vr
HARDWOODS		
Select white oak[HH]		
White oak	*Quercus alba*	vc
Swamp white oak	*Quercus bicolor*	r
Bur oak	*Quercus macrocarpa*	vc
Chinkapin oak	*Quercus muehlenbergii*	r
Other white oak[HH]		
Overcup oak	*Quercus lyrata*	vr
Post oak	*Quercus stellata*	r
Select red oak[HH]		
Northern red oak	*Quercus rubra*	vc
Other red oak[HH]		
Northern pin oak	*Quercus ellipsoidalis*	r
Shingle oak	*Quercus imbricaria*	c
Pin oak	*Quercus palustris*	r
Black oak	*Quercus velutina*	c
Select hickory[HH]		
Shellbark hickory	*Carya laciniosa*	vr
Shagbark hickory	*Carya ovata*	vc
Mockernut hickory	*Carya tomentosa*	r
Other hickory[HH]		
Bitternut hickory	*Carya cordiformis*	c
Basswood[SH]	*Tilia americana*	vc
Hard maple[HH]		
Black maple	*Acer nigrum*	c
Sugar maple	*Acer saccharum*	c
Soft maple[SH]		
Red maple	*Acer rubrum*	vr
Silver maple	*Acer saccharinum*	vc
Elm[SH]		
American elm	*Ulmus americana*	vc
Siberian elm	*Ulmus pumila*	r
Slippery elm	*Ulmus rubra*	c
Ash		
White ash[HH]	*Fraxinus americana*	c
Black ash[SH]	*Fraxinus nigra*	r
Green ash[HH]	*Fraxinus pennsylvanica*	c
Cottonwood[SH]	*Populus deltoides*	c
Willow[SH]	*Salix nigra*	c
Hackberry[SH]	*Celtis occidentalis*	c
Aspen[SH]		
Balsam poplar	*Populus balsamifera*	vr
Bigtooth aspen	*Populus grandidentata*	r
Quaking aspen	*Populus tremuloides*	r
Birch[SH]		
Paper birch	*Betula papyrifera*	r
River birch	*Betula nigra*	c
Black cherry[SH]	*Prunus serotina*	c
Black walnut[HH]	*Juglans nigra*	c
Other hardwoods		
Boxelder[SH]	*Acer negundo*	c
Ohio buckeye[SH]	*Aesculus glabra*	r
Northern catalpa[SH]	*Catalpa speciosa*	vr
Kentucky coffeetree[HH]	*Gymnocladus dioicus*	r
Flowering dogwood[HH]	*Cornus florida*	vr
Honeylocust[HH]	*Gleditsia triacanthos*	c
Butternut[SH]	*Juglans cinerea*	r
Red mulberry[SH]	*Morus rubra*	c
Sycamore[SH]	*Platanus occidentalis*	vr
Black locust[HH]	*Robinia pseudoacacia*	r
Sassafras[SH]	*Sassafras albidum*	vr
Noncommercial species		
American hornbeam	*Carpinus caroliniana*	r
Eastern redbud	*Cercis canadensis*	vr
Hawthorn	*Crataegus* spp.	c
Osage orange	*Maclura pomifera*	c
Apple	*Malus* spp.	r
Eastern hophornbeam	*Ostrya virginiana*	vc
Wild plum	*Prunus* spp.	r

[9] *The common and scientific names are based on Little (1979).*

[10] *Abundance is based on the number of trees ≥ 1 inch d.b.h. that were encountered on field plots (expressed as a proportion of the total number of trees); vr = very rare (<0.0005), r = rare (0.0005 to <0.005), c = common (0.005 to <0.05), and vc = very common (≥ 0.05).*

[HH] *This species or species group is considered a hard hardwood, with an average specific gravity greater than or equal to 0.50.*

[SH] *This species or species group is considered a soft hardwood, with an average specific gravity of less than 0.50.*

Pin cherry ..... *Prunus pennsylvanica* vr
Chokecherry ..... *Prunus virginiana* r

SHRUB SPECIES IN IOWA

TALL SHRUBS
Juneberry ..... *Amelanchier* spp.
Dogwood ..... *Cornus* spp.
Hazel ..... *Corylus* spp.
Alder buckthorn ..... *Rhamnus* spp.
Sumac ..... *Rhus* spp.
Elder ..... *Sambucus* spp.
Viburnum ..... *Viburnum* spp.
Prickly ash ..... *Zanthoxylum americanum*
LOW SHRUBS[11]
Honeysuckle ..... *Lonicera* spp.
Virginia creeper ..... *Parthenocissus* spp.
Poison ivy ..... *Rhus radicans*
Gooseberry-current ..... *Ribes* spp.
Rose ..... *Rosa* spp.
Raspberry-blackberry ..... *Rubus* spp.
Greenbrier ..... *Smilax* spp.
Snowberry ..... *Symphoricarpos* spp.
Yew ..... *Taxus canadensis*
Grape ..... *Vitis* spp.

DEFINITION OF TERMS

Average annual removals from growing stock.—The average net growing-stock volume in growing-stock trees removed annually for forest products (including roundwood products and logging residues) and for other uses (see Other removals). Average annual removals of growing stock are reported for a period of several years (1974 to 1989 in this report) and are based on information obtained from remeasurement plots (see Survey Procedures in Appendix).

Average annual removals from sawtimber.—The average net board foot sawtimber volume of live sawtimber trees removed annually for forest products (including roundwood products and other uses [see Other removals]). Average annual removals of sawtimber are reported for a period of several years (1974 to 1989 in this report) and are based on information obtained from remeasurement plots (see Survey Procedures in Appendix).

[11] *The common and scientific names are based on Fernald (1987).*

Basal area.—The area in square feet of the cross section at breast height of a single tree. When the basal area of all trees in a stand is summed, the result is usually expressed as square feet of basal area per acre.

Biomass.—The aboveground volume of all live trees (includes bark and excludes foliage) reported in green tons. Biomass is made up of four components:

Bole.—Biomass of a tree from 1 foot above the ground to a 4-inch top outside bark.

Tops and limbs.—Total biomass of a tree from a 1-foot stump minus the bole.

1- to 5-inch trees.—Total aboveground biomass of a tree from 1 to 5 inches in diameter at breast height.

Stump.—Biomass of a tree 5 inches d.b.h. and larger from the ground to a height of 1 foot.

Commercial species.—Tree species presently or prospectively suitable for industrial wood products. (Note: Excludes species of typically small size, poor form, or inferior quality such as hophornbeam and hawthorn.)

Commercial forest land.—(See Timberland).

County and municipal land.—Land owned by counties and local public agencies or municipalities, or land leased to these governmental units for 50 years or more.

Cropland.—Land under cultivation within the past 24 months; including cropland harvested, crop failures, cultivated summer fallow, idle cropland used only for pasture, orchards, and land in soil improvement crops, but excluding land cultivated in developing improved pasture.

Cull.—Portions of a tree that are unusable for industrial wood products because of rot, form, or other defect.

Current annual removals from growing stock.—The current net growing-stock volume in growing-stock trees removed annually for forest products (including roundwood products and logging residues) and for other uses (see Other removals).

Current annual removals of growing stock are reported for a single year (1988 in this report) and are based on a survey of primary wood processing mills to determine removals for products and on information from remeasurement plots (see Survey Procedures in Appendix) to determine removals due to land use change.

Current annual removals from sawtimber.—The current net board foot sawtimber volume of live sawtimber trees removed annually for forest products (including roundwood products and other uses [see Other removals]). Current annual removals of sawtimber are reported for a single year (1988 in this report) and are based on a survey of primary wood processing mills to determine removals for products and on information from remeasurement plots (see Survey Procedures in Appendix) to determine removals due to land use change.

Diameter classes.—A classification of trees based on diameter outside bark, measured at breast height (4.5 feet above the ground). (Note: D.b.h. is the common abbreviation for diameter at breast height. Two-inch diameter classes are commonly used in Forest Inventory and Analysis, with the even inch the approximate midpoint for a class. For example, the 6-inch class includes trees 5.0 through 6.9 inches d.b.h.).

Diameter at breast height (d.b.h.).—The outside bark diameter at 4.5 feet (1.37 m) above the forest floor on the uphill side of the tree. For the purpose of determining breast height, the forest floor includes the duff layer that may be present, but does not include unincorporated woody debris that may rise above the ground line.

Farm.—Any place from which $1,000 or more of agricultural products were produced and sold during the year.

Farmer-owned land.—Land owned by farm operators whether part of the farmstead or not. (Note: Excludes land leased by farm operators from nonfarm owners, such as railroad companies, States, corporations, or other individuals.)

Forest land.—Land at least 16.7 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use. (Note: Stocking is measured by comparing specified standards with basal area and/or number of trees, age or size, and spacing.) The minimum area for classification of forest land is 1 acre. Roadside, streamside, and shelterbelt strips of timber must have a crown width of at least 120 feet to qualify as forest land. Unimproved roads and trails, streams, or other bodies of water or clearings in forest areas shall be classed as forest if less than 120 feet wide. Also see definitions for Tree, Land, Timberland, Reserved forest land, Stocking, and Water.

Forest type.—A classification of forest land based on the species forming a plurality of live tree stocking. Major forest types in the State are:

Other softwoods.—Forests in which species in the other softwoods group, singly or in combination, comprise a plurality of the stocking.

Eastern redcedar.—Forests in which eastern redcedar comprises at least 50 percent of the stocking. (Common associates include the oaks and hickories.)

Eastern redcedar-hardwood.—Forests in which eastern redcedar comprises 25 to 50 percent of the stocking and eastern redcedar, oaks, and hickories in combination comprise a plurality of the stocking.

White oak-red oak-hickory.—Forests in which northern red oak, northern pin oak, black oak, white oak, bur oak, or hickories, singly or in combination, comprise a plurality of the stocking. (Common associates include American and slippery elm, hophornbeam, basswood, hackberry, and occasionally black cherry, white ash, and black walnut.)

White oak.—Forests in which the white oaks comprise at least 50 percent of the stocking. (Common associates include shagbark hickory, American elm, hophornbeam, northern red oak, slippery elm, and black oak.)

Bur oak.—Forests in which bur oak comprises at least 50 percent of the stocking.

(Common associates include American elm, slippery elm, and shagbark hickory.)

Elm-ash-soft maple.—Forests in which lowland elm, ash, and red maple, silver maple, and cottonwood, singly or in combination, comprise a plurality of the stocking. (Common associates include boxelder, hackberry, black willow, and occasionally honey locust, black walnut, and hawthorn.)

Cottonwood-aspen.—Forests in which cottonwood or aspen comprises at least 50 percent of the stocking or in which quaking aspen, bigtooth aspen, or paper birch, singly or in combination, comprise a plurality of the stocking. (Common associates include silver maple and black willow).

Maple-basswood.—Forests in which sugar maple, black maple, basswood, and upland elm, ash, and red maple, singly or in combination, comprise a plurality of the stocking. (Common associates include hophornbeam, black walnut, northern red oak, hackberry, and occasionally bur oak, black cherry, and bitternut hickory.)

Growing-stock trees.—Live trees of commercial species that meet specified standards of size, quality, and merchantability. (Note: Excludes rough, rotten, and dead trees.)

Growing-stock volume.—Net volume in cubic feet of growing-stock trees 5.0 inches d.b.h. and over, from 1 foot above the ground to a minimum 4.0-inch top diameter outside bark of the central stem or to the point where the central stem breaks into limbs. Cubic feet can be converted to standard cords by dividing by 79. One standard cord is 128 cubic feet of stacked wood, including bark and air.

Hard hardwoods.—Hardwood species with an average specific gravity greater than 0.50 such as oaks, hard maple, and hickories.

Hardwoods.—Dicotyledonous trees, usually broad-leaved and deciduous. (See Soft hardwoods and Hard hardwoods.)

Improved pasture.—Land currently improved for grazing by cultivating, seeding, irrigating, or clearing of trees or brush and less than 16.7 percent stocked with live trees.

Indian land.—All lands held in trust by the United States for individual Indians or tribes, or all lands, titles to which are held by individual Indians or tribes, subject to Federal restrictions against alienation.

Industrial wood.—All roundwood products, except fuelwood.

Land.—A. *Bureau of the Census.* Dry land and land temporarily or partly covered by water such as marshes, swamps, and river flood plains (omitting tidal flats below mean high tide); streams, sloughs, estuaries, and canals less than one-eighth of a statute mile wide; and lakes, reservoirs, and ponds less than 40 acres in area.

B. *Forest Inventory and Analysis.* The same as the Bureau of the Census, except minimum width of streams, etc., is 120 feet and minimum size of lakes, etc., is 1 acre.

Live trees.—Growing-stock, rough, and rotten trees 1.0 inch d.b.h. and larger.

Log grades.—A classification of logs based on external characteristics as indicators of quality or value. (See Appendix for specific grading factors used.)

Logging residues.—The unused growing-stock portions of trees cut or killed by logging.

Maintained road.—Any road, hard-topped or other surface, that is plowed or graded at least once a year. Includes rights-of-way that are cut or treated to limit herbaceous growth.

Marsh.—Nonforest land that characteristically supports low, generally herbaceous or shrubby vegetation and that is intermittently covered with water.

Merchantable.—Refers to a pulpwood or saw-log section that meets pulpwood or saw-log specifications, respectively.

Miscellaneous Federal land.—Federal land other than national forest and land administered by the Bureau of Land Management.

Miscellaneous private land.—Privately owned land other than forest-industry and farmer-owned land. Also includes Indian land in the Iowa report.

Mortality.—The volume of sound wood in growing-stock and sawtimber trees that die annually.

Net annual growth of growing stock.—The annual change in volume of sound wood in live sawtimber and poletimber trees and the total volume of trees entering these classes through ingrowth, less volume losses resulting from natural causes.

Net annual growth of sawtimber.—The annual change in the volume of live sawtimber trees and the total volume of trees reaching sawtimber size, less volume losses resulting from natural causes.

Net volume.—Gross volume less deductions for rot, sweep, or other defect affecting use for timber products.

Noncommercial species.—Tree species of typically small size, poor form, or inferior quality that normally do not develop into trees suitable for industrial wood products.

Nonforest land.—Land that has never supported forests, and land formerly forested where use for timber management is precluded by development for other uses. (Note: Includes areas used for crops, improved pasture, residential areas, city parks, improved roads of any width and adjoining clearings, powerline clearings of any width, and 1- to 40-acre areas of water classified by the Bureau of the Census as land. If intermingled in forest areas, unimproved roads and nonforest strips must be more than 120 feet wide and more than 1 acre in area to qualify as nonforest land.)

a. *Nonforest land without trees.*—Nonforest land with no live trees present.

b. *Nonforest land with trees.*—Nonforest land with one or more trees per acre at least 5 inches d.b.h.

Nonstocked land.—Timberland less than 16.7 percent stocked with growing-stock trees.

Other forest land.—Forest land not capable of producing 20 cubic feet per acre per year of industrial wood crops under natural conditions and not associated with urban or rural development. These sites often contain tree species that are not currently utilized for industrial wood production or trees of poor form, small size, or inferior quality that are unfit for industrial products. Low productivity may be the result of adverse site conditions such as sterile soil, dry climate, poor drainage, high elevation, and rockiness. This land is not withdrawn from timber utilization. Formerly called woodland.

Other removals.—Growing-stock trees removed but not utilized for products, or trees left standing but "removed" from the timberland classification by land use change. Examples are removals from cultural operations such as timber stand improvement work, land clearing, and changes in land use.

Ownership.—Property owned by one owner, despite the number of parcels in a specified area.

Ownership size class.—The amount of timberland owned by one owner, despite the number of parcels.

Owner tenure.—The length of time a property has been held by the owner.

Pasture.—Land presently used for grazing or under cultivation to develop grazing.

Pastured timberland.—Timberland for which the primary use is wood production, but presently used for grazing.

Plant byproducts.—Plant residues used for products such as mulch, pulp chips, and fuelwood.

Plant residues.—Wood and bark materials generated at manufacturing plants during production of other products.

Poletimber stand.—(See Stand-size class.)

Poletimber tree.—A live tree of commercial species at least 5.0 inches d.b.h. but smaller than sawtimber size.

Potential productivity class.—A classification of forest land in terms of inherent capacity to grow crops of industrial wood based on fully stocked natural stands.

Public land.—A class of land that includes county and municipal land, miscellaneous Federal land, and State land.

Reserved forest land.—Forest land withdrawn from timber utilization through statute, administrative regulation, designation, or exclusive use for Christmas tree production, as indicated by annual shearing.

Rotten trees.—Live trees of commercial species that do not contain at least one 12-foot saw log or two saw logs 8 feet or longer, now or prospectively, and/or do not meet regional specifications for freedom from defect primarily because of rot; that is, when more than 50 percent of the cull volume in a tree is rotten.

Rough trees.—(a) Live trees of commercial species that do not contain at least one merchantable 12-foot saw log or two saw logs 8 feet or longer, now or prospectively, and/or do not meet regional specifications for freedom from defect primarily because of roughness or poor form, and (b) all live trees of noncommercial species.

Roundwood products.—Logs, bolts, or other round sections (including chips from roundwood) cut from trees for industrial or consumer uses. (Note: Includes saw logs, veneer logs and bolts; cooperage logs and bolts; pulpwood; fuelwood; piling; poles; posts; hewn ties; mine timbers; and various other round, split, or hewn products.)

Salvable dead trees.—Standing or down dead trees considered merchantable by regional standards.

Saplings.—Live trees 1.0 to 5.0 inches d.b.h.

Sapling-seedling stands.—(See Stand-size class.)

Saw log.—A log meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight, with a minimum diameter outside bark (d.o.b.) for softwoods of 7 inches (9 inches for hardwoods) or other combinations of size and defect specified by regional standards.

Saw-log portion.—That part of the bole of sawtimber trees between the stump and the saw-log top.

Saw-log top.—The point on the bole of sawtimber trees above which a saw log cannot be produced. The minimum saw log top is 7.0 inches d.o.b. for softwoods and 9.0 inches d.o.b. for hardwoods.

Sawtimber stands.—(See Stand-size class.)

Sawtimber tree.—A live tree of commercial species containing at least a 12-foot saw log or two noncontiguous saw logs 8 feet or longer, and meeting regional specifications for freedom from defect. Softwoods must be at least 9.0 inches d.b.h. Hardwoods must be at least 11.0 inches d.b.h.

Sawtimber volume.—Net volume of the saw-log portion of live sawtimber in board feet, International 1/4-inch rule (unless specified otherwise), from stump to a minimum 7-inch top diameter outside bark (d.o.b.) for softwoods and a minimum 9-inch top d.o.b. for hardwoods.

Seedlings.—Live trees less than 1.0 inch d.b.h. that are expected to survive. Only softwood seedlings more than 6 inches tall and hardwood seedlings more than 1 foot tall are counted.

Short-log (rough tree).—Sawtimber-size trees of commercial species that contain at least one merchantable 8- to 11-foot saw log but not a 12-foot saw log.

Site index.—An expression of forest site quality based on the height of a free-growing dominant or codominant tree of a representative species in the forest type at age 50.

Soft hardwoods.—Hardwood species with an average specific gravity less than 0.50, such as cottonwood, basswood, and willow.

Softwoods.—Coniferous trees, usually evergreen, having needles or scale-like leaves.

Stand.—A group of trees on a minimum of 1 acre of forest land that is stocked by forest trees of any size.

Stand-age class.—Age of the main stand. Main stand refers to trees of the dominant forest type and stand-size class.

Stand-size class.—A classification of stocked (see Stocking) forest land based on the size class of live trees on the area; that is, sawtimber, poletimber, or seedlings and saplings.

a. *Sawtimber stands.*—Stands with half or more of live stocking in sawtimber or poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

b. *Poletimber stands.*—Stands with half or more live stocking in poletimber and/or sawtimber trees, and with poletimber stocking exceeding that of sawtimber.

c. *Sapling-seedling stands.*—Stands with more than half the live stocking in saplings and/or seedlings.

State land.—Land owned by States or leased to them for 50 years or more.

Stocking.—The degree of occupancy of land by trees, measured by basal area and/or the number of trees in a stand by size or age and spacing, compared to the basal area and/or number of trees required to fully utilize the growth potential of the land; that is, the stocking standard.

A stocking percent of 100 indicates full utilization of the site and is equivalent to 80 square feet of basal area per acre in trees 5 inches d.b.h. and larger. In a stand of trees less than 5 inches d.b.h., a stocking percent of 100 would indicate that the present number of trees is sufficient to produce 80 square feet of basal area per acre when the trees reach 5 inches d.b.h.

Stands are grouped into the following stocking classes:

Overstocked stands.—Stands in which stocking of trees is 133.0 percent or more.

Fully stocked stands.—Stands in which stocking of trees is from 100.0 to 132.9 percent.

Moderately stocked stands.—Stands in which stocking of trees is from 60.0 to 99.9 percent.

Poorly stocked stands.—Stands in which stocking of trees is from 16.7 to 59.9 percent.

Nonstocked areas.—Timberland on which stocking of trees is less than 16.7 percent.

Timberland.—Forest land producing or capable of producing crops of industrial wood and not withdrawn from timber utilization. (Note: Areas qualifying as timberland are capable of producing more than 20 cubic feet per acre per year of annual growth when managed. Currently inaccessible and inoperable areas are included unless the areas involved are small and unlikely to become suitable for producing industrial wood in the future.) Formerly called commercial forest land. (Also see definition of Pastured timberland.)

Timber products output.—All timber products cut from roundwood and byproducts of wood manufacturing plants. Roundwood products include logs, bolts, or other round sections cut from growing-stock trees, cull trees, salvable dead trees, trees on nonforest land, noncommercial species, sapling-size trees, and limbwood. Byproducts from primary manufacturing plants include slabs, edging, trimmings, miscuts, sawdust, shavings, veneer cores and clippings, and screenings of pulpmills that are used as pulpwood chips or other products.

Tree.—Woody plant having a well-developed stem and usually more than 12 feet tall at maturity.

Tree biomass.—The total aboveground weight (including the bark) of all trees from 1 to 5 inches in d.b.h., and the total aboveground weight (including the bark) from a 1-foot stump for trees more than 5 inches in diameter.

Tree grade.—A classification of the lower 16 feet of the bole of standing trees based on external characteristics as indicators of the quality and quantity of lumber produced from the tree (see the Appendix for details).

Tree size class.—A classification of trees based on diameter at breast height, including sawtimber trees, poletimber trees, saplings, and seedlings.

Upper-stem portion.—That part of the bole of sawtimber trees above the saw-log top to a minimum top diameter of 4.0 inches outside bark or to the point where the central stem breaks into limbs.

Urban and other areas.—Areas within the legal boundaries of cities and towns; suburban areas developed for residential, industrial, or recreational purposes; schoolyards; cemeteries; roads; railroads; airports; beaches; powerlines and other rights-of-way; or other nonforest land not included in any other specified land use class.

Urban forest land.—Land that would otherwise meet the criteria for timberland, but in an urban-suburban area surrounded by commercial, industrial, or residential development.

Water.—(a) *Bureau of the Census.*—Permanent inland water surfaces, such as lakes, reservoirs, and ponds at least 40 acres in area; and streams, sloughs, estuaries, and canals at least one-eighth of a statute mile wide.

(b) *Noncensus.*—Permanent inland water surfaces, such as lakes, reservoirs, and ponds from 1 to 39.9 acres in area; and streams, sloughs, estuaries, and canals from 120 feet to one-eighth of a statute mile wide.

Windbreaks.—A group of trees whose primary use is to protect buildings currently in use.

Wooded pasture.—Improved pasture with more than 16.7 percent stocking in live trees but less than 25 percent stocking in growing-stock trees. Area is currently improved for grazing or there is other evidence of grazing.

Wooded strip.—An acre or more of natural continuous forest land that would otherwise meet survey standards for timberland except that it is less than 120 feet wide.

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Unit and county	Land area	Forest land						Nonforest land with trees
		All forest land	Timber-land	Sampling error for timberland	Timberland as a percent of land area	Other forest land	Reserved forest land	
	Thousand acres			*Percent*		*Thousand acres*		
Northeastern Unit								
Alamakee	405.4	104.1	100.7	8.4	24.8	2.8	0.6	21.0
Benton	459.7	14.2	13.8	22.8	3.0	0.4	--	5.7
Black Hawk	366.6	13.0	11.3	25.2	3.1	0.4	1.3	4.6
Bremer	281.1	14.5	13.9	22.7	4.9	0.1	0.5	2.9
Buchanan	366.2	13.5	13.2	23.3	3.6	0.2	0.1	3.7
Butler	372.4	11.2	10.4	26.2	2.8	0.2	0.6	4.7
Cedar	372.7	20.4	20.1	18.9	5.4	0.2	0.1	4.5
Chickasaw	322.9	8.5	8.2	29.6	2.5	0.3	--	3.3
Clayton	498.2	106.1	103.5	8.3	20.8	0.8	1.8	17.1
Clinton	444.7	27.9	27.2	16.2	6.1	0.1	0.6	4.4
Delaware	369.9	24.5	22.3	17.9	6.0	0.3	1.9	4.9
Dubuque	388.3	51.2	48.5	12.2	12.5	0.7	2.0	10.1
Fayette	468.0	38.9	38.2	13.7	8.2	0.4	0.3	9.5
Floyd	320.9	6.6	6.0	34.6	1.9	0.2	0.4	2.5
Grundy	320.8	0.4	0.4	*	0.1	--	--	0.8
Howard	302.6	8.4	7.9	30.1	2.6	0.1	0.4	3.6
Jackson	408.3	73.8	71.9	10.0	17.6	1.3	0.6	15.5
Johnson	393.0	38.2	28.8	15.8	7.3	0.3	9.1	5.8
Jones	368.8	28.7	28.0	16.0	7.6	0.4	0.3	3.7
Linn	463.4	46.2	44.4	12.7	9.6	0.5	1.3	7.6
Mitchell	300.5	9.0	8.9	28.4	3.0	0.1	--	3.5
Scott	293.8	11.3	9.7	27.2	3.3	0.7	0.9	2.6
Tama	461.7	22.6	21.3	18.3	4.6	0.4	0.9	7.2
Winneshiek	441.5	48.4	47.8	12.2	10.8	0.4	0.2	10.7
Total	9,191.4	741.6	706.4	3.2	7.7	11.3	23.9	159.9
Southeastern Unit								
Appanoose	318.5	40.4	34.5	14.4	10.8	0.2	5.7	10.9
Boone	367.0	30.3	24.3	17.2	6.6	0.1	5.9	4.4
Clarke	275.8	29.8	29.1	15.7	10.6	0.1	0.6	11.7
Dallas	378.1	22.4	20.3	18.8	5.4	0.1	2.0	6.5
Davis	322.6	42.5	40.5	13.3	12.6	0.1	1.9	10.7
Decatur	342.5	46.1	44.3	12.7	12.9	0.1	1.7	15.3
Des Moines	265.0	42.0	41.3	13.2	15.6	0.1	0.6	5.4
Guthrie	377.7	30.8	30.0	15.5	7.9	0.1	0.7	8.0
Hamilton	368.8	8.1	7.6	30.7	2.1	--	0.5	2.0
Hardin	364.2	13.6	12.8	23.7	3.5	--	0.8	3.7
Henry	279.0	34.9	33.0	14.7	11.8	0.1	1.8	8.0
Iowa	375.8	23.3	22.7	17.8	6.0	--	0.6	5.7
Jasper	468.0	17.2	16.4	20.9	3.5	0.1	0.7	8.9
Jefferson	281.4	23.4	22.6	17.8	8.0	--	0.8	8.3
Keokuk	371.3	31.2	30.8	15.3	8.3	0.2	0.2	9.9
Lee	334.0	60.7	59.0	11.0	17.7	0.1	1.6	14.8
Louisa	257.3	30.3	28.5	15.9	11.1	--	1.8	5.7
Lucas	276.8	32.6	29.3	15.6	10.6	0.1	3.2	10.7
Madison	360.1	45.6	45.0	12.6	12.5	0.1	0.5	11.9
Mahaska	365.7	23.5	22.7	17.8	6.2	0.1	0.7	7.6
Marion	358.5	42.7	38.4	13.7	10.7	0.1	4.2	12.6
Marshall	366.7	13.5	13.3	23.2	3.6	0.1	0.1	4.2
Monroe	277.7	46.4	45.2	12.6	16.3	0.1	1.1	13.5
Muscatine	282.6	25.2	24.0	17.3	8.5	0.1	1.1	6.7
Polk	372.4	25.1	20.0	18.9	5.4	0.1	5.0	6.3
Poweshiek	374.5	8.3	8.1	29.7	2.2	--	0.2	4.1
Story	367.0	10.8	10.3	26.4	2.8	--	0.5	3.3
Van Buren	309.5	58.5	55.8	11.3	18.0	0.1	2.6	12.5
Wapello	277.9	36.5	35.6	14.2	12.8	0.1	0.8	11.2
Warren	366.5	42.2	41.0	13.2	11.2	0.2	1.0	13.5
Washington	364.9	23.6	22.3	17.9	6.1	0.1	1.2	7.7
Wayne	336.9	21.2	19.2	19.3	5.7	0.1	1.9	8.9
Webster	459.6	21.0	18.9	19.5	4.1	--	2.1	4.0
Total	11,264.3	1,003.7	946.8	2.8	8.4	2.8	54.1	278.6

(Table 3 continued on next page)

*Indicates that the sampling error was greater than 50 percent.

(Table 3 continued)

Unit and county	Land area	Forest land						Nonforest land with trees
		All forest land	Timber-land	Sampling error for timberland	Timberland as a percent of land area	Other forest land	Reserved forest land	
	Thousand acres			*Percent*		*Thousand acres*		
Western Unit								
Adair	364.5	7.4	7.0	32.0	1.9	0.2	0.2	2.2
Adams	272.0	9.0	8.7	28.7	3.2	0.1	0.2	3.3
Audubon	284.5	2.5	2.5	*	0.9	--	--	1.5
Buena Vista	367.8	3.1	3.1	48.1	0.8	--	--	0.4
Calhoun	365.6	0.9	0.9	*	0.2	--	--	0.4
Carroll	364.8	3.2	3.1	48.1	0.8	0.1	--	0.7
Cass	361.5	6.3	5.9	34.8	1.6	0.1	0.3	3.8
Cerro Gordo	364.4	1.6	1.6	*	0.4	--	--	1.0
Cherokee	369.3	8.6	8.6	28.9	2.3	--	--	0.9
Clay	363.9	4.9	4.9	38.2	1.3	--	--	0.6
Crawford	457.2	7.9	7.8	30.3	1.7	0.1	--	2.8
Dickinson	243.6	0.9	0.9	*	0.4	--	--	0.1
Emmet	252.0	2.3	2.3	*	0.9	--	--	0.8
Franklin	372.9	4.5	4.5	39.9	1.2	--	--	1.0
Fremont	329.5	17.6	15.6	21.4	4.7	0.4	1.6	3.9
Greene	365.6	10.1	9.5	27.5	2.6	0.4	0.2	1.2
Hancock	365.4	1.2	1.2	*	0.3	--	--	0.6
Harrison	446.4	28.5	27.1	16.3	6.1	0.9	0.5	4.4
Humboldt	279.4	3.0	3.0	48.9	1.1	--	--	1.0
Ida	276.4	0.4	0.4	*	0.1	--	--	0.2
Kossuth	623.3	5.0	5.0	37.9	0.8	--	--	1.5
Lyon	376.1	4.6	4.6	39.5	1.2	--	--	0.4
Mills	281.1	11.6	11.2	25.3	4.0	0.1	0.3	3.0
Monona	446.1	32.6	30.1	15.4	6.7	1.0	1.5	6.4
Montgomery	271.2	6.2	5.0	37.9	1.8	0.1	1.1	1.7
O'Brien	367.0	2.7	2.7	*	0.7	--	--	0.2
Osceola	255.0	0.2	0.2	*	0.1	--	--	--
Page	342.6	7.1	6.6	32.9	1.9	0.1	0.4	4.1
Palo Alto	359.5	2.6	2.6	*	0.7	--	--	0.4
Plymouth	553.0	7.6	7.6	30.7	1.4	--	--	1.2
Pocahontas	369.2	1.1	1.1	*	0.3	--	--	0.4
Pottawattamie	610.1	19.2	17.9	20.0	2.9	0.3	1.0	7.5
Ringgold	342.7	16.5	16.1	21.1	4.7	0.1	0.3	6.7
Sac	368.9	2.7	2.7	*	0.7	--	--	0.7
Shelby	378.2	2.6	2.4	*	0.6	--	0.2	1.6
Sioux	492.0	3.0	3.0	48.9	0.6	--	--	0.3
Taylor	343.7	10.1	9.5	27.5	2.8	--	0.6	5.2
Union	272.5	17.2	16.5	20.8	6.1	0.4	0.3	5.6
Winnebago	256.5	0.9	0.9	*	0.4	--	--	0.4
Woodbury	559.0	18.1	16.6	20.8	3.0	0.4	1.1	4.3
Worth	256.6	4.9	4.9	38.2	1.9	--	--	0.5
Wright	370.3	4.5	4.5	39.9	1.2	--	--	0.6
Total	15,361.3	304.9	290.3	5.0	1.9	4.8	9.8	83.5
All counties	35,817.0	2,050.2	1,943.5	1.9	5.4	18.9	87.8	522.0

*Indicates that the sampling error was greater than 50 percent.

Table 4.--Area of timberland by Forest Survey Unit and ownership class, Iowa, 1990

(In thousand acres)

Forest Survey Unit	All owners	Ownership class		
		Public owners	Farmer	Miscellaneous Private
Northeastern Unit	706.4	54.1	517.5	134.8
Southeastern Unit	946.8	64.5	549.2	333.1
Western Unit	290.3	37.2	175.4	77.7
All Units	1,943.5	155.8	1,242.1	545.6

Table 5.--Area of timberland by Forest Survey Unit and forest type, Iowa, 1990

(In thousand acres)

Forest Survey Unit	All types	Forest type									
		Eastern redcedar	Eastern redcedar-hardwood	Other softwoods	White oak-red oak-hickory	White oak	Bur oak	Elm-ash-soft maple	Cotton-wood-aspen	Maple-basswood	Non-stocked
Northeastern Unit	706.4	9.2	11.6	6.3	238.0	15.9	20.1	148.2	10.0	244.4	2.7
Southeastern Unit	946.8	3.9	7.3	--	414.2	69.3	27.1	227.7	8.3	189.0	--
Western Unit	290.3	10.6	5.0	--	68.6	2.5	37.6	97.0	10.8	58.2	--
All Units	1,943.5	23.7	23.9	6.3	720.8	87.7	84.8	472.9	29.1	491.6	2.7

Table 6.--Area of timberland by Forest Survey Unit and stand-size class, Iowa, 1990

(In thousand acres)

Forest Survey Unit	All stands	Stand-size class			
		Sawtimber	Poletimber	Seedling & Sapling	Nonstocked
Northeastern Unit	706.4	519.3	92.8	91.6	2.7
Southeastern Unit	946.8	589.8	182.5	174.5	--
Western Unit	290.3	155.6	112.0	22.7	--
All Units	1,943.5	1,264.7	387.3	288.8	2.7

Table 7.--Area of timberland by Forest Survey Unit and potential productivity class, Iowa,1990

(In thousand acres)

Forest Survey Unit	All classes	Potential productivity class (cubic feet of growth per acre per year)				
		165+	120-164	85-119	50-84	20-49
Northeastern Unit	706.4	3.2	29.8	250.5	309.3	113.6
Southeastern Unit	946.8	12.3	24.5	254.9	485.1	170.0
Western Unit	290.3	7.1	5.4	67.8	117.0	93.0
All Units	1,943.5	22.6	59.7	573.2	911.4	376.6

Table 8.--Area of timberland by Forest Survey Unit and stocking class of growing-stock trees, Iowa, 1990

(In thousand acres)

Forest Survey Unit	All classes	Stocking percent of growing-stock trees				
		Nonstocked	Poorly stocked	Moderately stocked	Fully stocked	Over-stocked
Northeastern Unit	706.4	16.2	210.9	399.5	76.6	3.2
Southeastern Unit	946.8	22.8	364.0	411.4	142.5	6.1
Western Unit	290.3	5.4	171.2	88.5	23.0	2.2
All Units	1,943.5	44.4	746.1	899.4	242.1	11.5

Table 9.--Area of timberland by ownership class, stocking class of growing-stock trees, and Forest Survey Unit, Iowa, 1990

(In thousand acres)

Unit and county	All classes	Stocking percent of growing-stock trees				
		Nonstocked	Poorly stocked	Moderately stocked	Fully stocked	Over-stocked
All Units						
Public	155.8	8.4	46.8	75.4	25.2	--
Farmer	1,242.1	19.8	547.1	545.0	124.1	6.1
Miscellaneous private	545.6	16.2	152.2	279.0	92.8	5.4
All owners	1,943.5	44.4	746.1	899.4	242.1	11.5
Northeastern Unit						
Public	54.1	2.7	27.4	14.4	9.6	--
Farmer	517.5	9.5	170.7	296.8	40.5	--
Miscellaneous private	134.8	4.0	12.8	88.3	26.5	3.2
All owners	706.4	16.2	210.9	399.5	76.6	3.2
Southeastern Unit						
Public	64.5	3.1	3.1	45.1	13.2	--
Farmer	549.2	7.5	255.6	204.1	75.9	6.1
Miscellaneous private	333.1	12.2	105.3	162.2	53.4	--
All owners	946.8	22.8	364.0	411.4	142.5	6.1
Western Unit						
Public	37.2	2.6	16.3	15.9	2.4	--
Farmer	175.4	2.8	120.8	44.1	7.7	--
Miscellaneous private	77.7	--	34.1	28.5	12.9	2.2
All owners	290.3	5.4	171.2	88.5	23.0	2.2

Table 10.--Area of timberland by forest type, ownership class, and Forest Survey Unit, Iowa, 1990

(In thousand acres)

Forest type	All owners	Ownership class		
		Public	Farmer	Miscellaneous private
All Units				
Eastern redcedar	23.7	--	10.8	12.9
E. redcedar-hardwood	23.9	--	17.6	6.3
Other softwoods	6.3	6.3	--	--
White-red oak-hickory	720.8	38.9	459.6	222.3
White oak	87.7	8.1	47.0	32.6
Bur oak	84.8	2.7	66.7	15.4
Elm-ash-soft maple	472.9	74.5	269.0	129.4
Cottonwood-aspen	29.1	2.1	13.5	13.5
Maple-basswood	491.6	20.5	357.9	113.2
Nonstocked	2.7	2.7	--	--
All types	1,943.5	155.8	1,242.1	545.6
Northeastern Unit				
Eastern redcedar	9.2	--	2.4	6.8
E. redcedar-hardwood	11.6	--	9.0	2.6
Other softwoods	6.3	6.3	--	--
White-red oak-hickory	238.0	18.2	179.9	39.9
White oak	15.9	--	15.9	--
Bur oak	20.1	--	20.1	--
Elm-ash-soft maple	148.2	20.1	93.5	34.6
Cottonwood-aspen	10.0	--	7.3	2.7
Maple-basswood	244.4	6.8	189.4	48.2
Nonstocked	2.7	2.7	--	--
All types	706.4	54.1	517.5	134.8
Southeastern Unit				
Eastern redcedar	3.9	--	--	3.9
E. redcedar-hardwood	7.3	--	3.6	3.7
Other softwoods	--	--	--	--
White-red oak-hickory	414.2	20.7	243.4	150.1
White oak	69.3	8.1	31.1	30.1
Bur oak	27.1	2.7	16.3	8.1
Elm-ash-soft maple	227.7	21.4	125.4	80.9
Cottonwood-aspen	8.3	2.1	6.2	--
Maple-basswood	189.0	9.5	123.2	56.3
Nonstocked	--	--	--	--
All types	946.8	64.5	549.2	333.1
Western Unit				
Eastern redcedar	10.6	--	8.4	2.2
E. redcedar-hardwood	5.0	--	5.0	--
Other softwoods	--	--	--	--
White-red oak-hickory	68.6	--	36.3	32.3
White oak	2.5	--	--	2.5
Bur oak	37.6	--	30.3	7.3
Elm-ash-soft maple	97.0	33.0	50.1	13.9
Cottonwood-aspen	10.8	--	--	10.8
Maple-basswood	58.2	4.2	45.3	8.7
Nonstocked	--	--	--	--
All types	290.3	37.2	175.4	77.7

Table 11.--Area of timberland by forest type, stand-size class, and Forest Survey Unit, Iowa, 1990

(In thousand acres)

Unit and forest type	All stands	Stand-size class			
		Sawtimber	Poletimber	Seedling & Sapling	Nonstocked
All Units					
Eastern redcedar	23.7	8.4	11.4	3.9	--
E. redcedar-hardwood	23.9	14.4	3.2	6.3	--
Other softwoods	6.3	--	--	6.3	--
White-red oak-hickory	720.8	487.3	155.2	78.3	--
White oak	87.7	70.4	17.3	--	--
Bur oak	84.8	64.2	17.8	2.8	--
Elm-ash-soft maple	472.9	327.1	91.7	54.1	--
Cottonwood-aspen	29.1	21.8	--	7.3	--
Maple-basswood	491.6	271.1	90.7	129.8	--
Nonstocked	2.7	--	--	--	2.7
All types	1,943.5	1,264.7	387.3	288.8	2.7
Northeastern Unit					
Eastern redcedar	9.2	--	9.2	--	--
E. redcedar-hardwood	11.6	5.3	--	6.3	--
Other softwoods	6.3	--	--	6.3	--
White-red oak-hickory	238.0	207.2	25.5	5.3	--
White oak	15.9	15.9	0.0	--	--
Bur oak	20.1	20.1	0.0	--	--
Elm-ash-soft maple	148.2	103.4	22.2	22.6	--
Cottonwood-aspen	10.0	2.7	0.0	7.3	--
Maple-basswood	244.4	164.7	35.9	43.8	--
Nonstocked	2.7	--	--	--	2.7
All types	706.4	519.3	92.8	91.6	2.7
Southeastern Unit					
Eastern redcedar	3.9	--	--	3.9	--
E. redcedar-hardwood	7.3	7.3	--	--	--
Other softwoods	--	--	--	--	--
White-red oak-hickory	414.2	254.1	96.2	63.9	--
White oak	69.3	54.5	14.8	--	--
Bur oak	27.1	24.4	2.7	--	--
Elm-ash-soft maple	227.7	166.4	32.6	28.7	--
Cottonwood-aspen	8.3	8.3	--	--	--
Maple-basswood	189.0	74.8	36.2	78.0	--
Nonstocked	--	--	--	--	--
All types	946.8	589.8	182.5	174.5	--
Western Unit					
Eastern redcedar	10.6	8.4	2.2	--	--
E. redcedar-hardwood	5.0	1.8	3.2	--	--
Other softwoods	--	--	--	--	--
White-red oak-hickory	68.6	26.0	33.5	9.1	--
White oak	2.5	--	2.5	--	--
Bur oak	37.6	19.7	15.1	2.8	--
Elm-ash-soft maple	97.0	57.3	36.9	2.8	--
Cottonwood-aspen	10.8	10.8	--	--	--
Maple-basswood	58.2	31.6	18.6	8.0	--
Nonstocked	--	--	--	--	--
All types	290.3	155.6	112.0	22.7	--

Table 12.--Number of all live trees on timberland by species group and diameter class, Iowa, 1990

(In thousand trees)

Species group	All classes	Diameter class (inches at breast height) 1.0-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods													
Eastern redcedar	24,912	9,723	6,936	4,797	1,794	1,037	392	128	55	22	22	6	--
Other softwoods	659	--	378	109	107	50	--	9	--	6	--	--	--
Total	25,571	9,723	7,314	4,906	1,901	1,087	392	137	55	28	22	6	--
Hardwoods													
Select white oak	52,792	9,933	8,016	7,242	7,635	5,390	4,502	3,085	2,331	1,837	1,070	1,514	237
Other white oak	392	--	--	93	144	109	15	9	14	--	8	--	--
Select red oak	17,162	3,906	1,989	1,619	1,521	1,560	1,676	1,566	1,256	786	496	670	117
Other red oak	19,295	6,780	2,499	2,817	2,197	1,368	1,153	985	609	423	167	262	35
Select hickory	53,615	21,741	14,379	7,964	4,471	2,212	1,409	820	300	197	57	65	--
Other hickory	29,077	17,034	6,177	2,559	1,630	879	343	277	84	47	47	--	--
Basswood	36,563	21,027	5,013	2,559	2,059	1,744	1,588	780	725	489	230	305	44
Hard maple	16,165	9,618	1,869	1,367	803	728	575	381	367	192	110	137	18
Soft maple	28,268	9,435	5,397	3,112	2,713	2,141	1,649	1,239	763	558	402	675	184
Elm	191,502	116,739	38,790	18,452	8,175	4,507	2,777	1,155	428	245	127	105	2
Ash	33,005	16,413	7,995	3,287	1,901	1,354	901	410	247	165	116	199	17
Cottonwood	8,201	3,357	921	398	700	395	502	370	345	221	216	550	226
Willow	13,973	8,058	1,056	1,137	1,105	806	613	472	265	168	153	130	10
Hackberry	44,835	24,276	10,443	4,543	2,368	1,583	646	539	166	91	79	81	20
Aspen	6,497	3,495	987	528	308	422	395	217	108	24	13	--	--
Birch	4,241	1,188	771	760	563	231	194	260	160	71	15	20	8
Black cherry	25,785	15,792	4,344	2,411	1,503	726	576	236	129	38	9	20	1
Black walnut	16,774	6,297	2,553	2,032	1,519	1,608	1,196	795	340	198	156	80	--
Other hardwoods	69,049	34,176	14,754	7,603	4,791	3,423	2,057	1,004	518	266	230	180	47
Noncommercial sp.	137,385	101,313	27,789	5,944	1,555	649	98	--	30	--	--	7	--
Total	804,576	430,578	155,742	76,427	47,661	31,835	22,865	14,600	9,185	6,016	3,701	5,000	966
All species	830,147	440,301	163,056	81,333	49,562	32,922	23,257	14,737	9,240	6,044	3,723	5,006	966

Table 13.--Number of growing-stock trees on timberland by species group and diameter class, Iowa, 1990

(In thousand trees)

Species group	All classes	Diameter class (inches at breast height) 1.0-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods													
Eastern redcedar	20,518	9,723	5,700	3,436	1,038	438	142	19	--	16	--	6	--
Other softwoods	419	--	378	--	32	--	--	9	--	--	--	--	--
Total	20,937	9,723	6,078	3,436	1,070	438	142	28	--	16	--	6	--
Hardwoods													
Select white oak	37,938	9,933	5,658	4,741	5,287	3,572	2,751	2,068	1,536	1,164	555	642	31
Other white oak	271	--	--	93	105	42	15	9	7	--	--	--	--
Select red oak	14,636	3,906	1,896	1,570	1,066	1,312	1,282	1,267	979	578	326	410	44
Other red oak	15,628	6,780	2,172	1,901	1,302	1,022	785	721	443	251	93	149	9
Select hickory	50,108	21,741	13,488	6,981	3,751	1,973	1,068	652	223	154	37	40	--
Other hickory	27,166	17,034	5,217	2,297	1,257	732	298	204	60	42	25	--	--
Basswood	32,483	21,027	4,083	1,835	1,434	1,247	1,157	579	541	332	130	115	3
Hard maple	14,658	9,618	1,602	1,166	602	551	424	232	248	107	59	49	--
Soft maple	22,073	9,435	4,206	2,154	1,587	1,239	1,005	855	523	354	244	420	51
Elm	169,883	116,424	30,732	12,484	5,088	2,318	1,668	689	267	116	54	41	2
Ash	27,763	16,314	5,334	2,373	1,517	956	562	345	160	61	74	64	3
Cottonwood	7,619	3,261	804	294	679	395	446	331	310	216	202	526	155
Willow	11,528	8,058	693	710	639	523	323	269	125	80	56	49	3
Hackberry	40,943	24,192	8,973	3,542	1,894	1,177	383	444	136	79	62	59	2
Aspen	5,784	3,495	783	270	252	399	322	153	82	15	13	--	--
Birch	3,626	1,188	771	551	384	188	143	222	104	50	10	11	4
Black cherry	20,628	15,792	2,298	1,021	631	316	321	148	77	13	5	6	--
Black walnut	13,616	6,297	1,944	1,322	987	1,088	833	592	250	156	116	31	--
Other hardwoods	45,110	33,825	7,644	1,612	910	501	279	170	50	27	52	36	4
Total	561,461	328,320	98,298	46,917	29,372	19,551	14,065	9,950	6,121	3,795	2,113	2,648	311
All species	582,398	338,043	104,376	50,353	30,442	19,989	14,207	9,978	6,121	3,811	2,113	2,654	311

Table 14.--Net volume of timber on timberland by class of timber and major species group, Iowa, 1990

(In thousand cubic feet)

Class of timber	All species	Major species group		
		Softwoods	Soft hardwoods	Hard hardwoods
Live trees				
Growing-stock trees				
Sawtimber				
Saw-log portion	1,062,182	5,410	445,232	611,540
Upper stem portion	158,941	918	60,730	97,293
Total	1 221,123	6 328	505,962	708,833
Poletimber	441,890	11,804	185,156	244,930
All growing-stock trees	1,663,013	18,132	691,118	953,763
Cull trees				
Short-log trees	183,227	1,358	62,825	119,044
Rough trees				
Sawtimber	365,232	10,325	135,557	219,350
Poletimber	215,138	6,617	128,043	80,478
Total	580,370	16 942	263,600	299,828
Rotten trees				
Sawtimber	97,015	--	53,981	43,034
Poletimber	6,409	--	3,796	2,613
Total	103,424	--	57,777	45,647
All cull trees	867,021	18,300	384,202	464,519
All live trees	2,530,034	36,432	1,075,320	1,418,282
Salvable dead trees				
Sawtimber	63,706	116	16,696	46,894
Poletimber	16,032	--	10,919	5,113
Total	79,738	116	27,615	52,007
All classes	2,609,772	36,548	1,102,935	1,470,289

Table 15.--Net volume of growing stock on timberland by species group and diameter class, Iowa, 1990

(In thousand cubic feet)

Species group	All classes	Diameter class (inches at breast height) 5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods											
Eastern redcedar	17,824	7,012	4,668	3,378	1,679	330	--	473	--	284	--
Other softwoods	308	--	124	--	--	184	--	--	--	--	--
Total	18,132	7,012	4,792	3,378	1,679	514	--	473	--	284	--
Hardwoods											
Select white oak	334,313	11,372	26,411	32,453	40,344	44,769	47,235	47,923	28,944	50,390	4,472
Other white oak	1,689	288	452	367	172	190	220	--	--	--	--
Select red oak	188,537	4,343	6,100	12,914	20,086	28,966	31,119	25,294	17,537	34,795	7,383
Other red oak	89,521	4,253	6,600	8,744	11,631	15,713	14,077	10,792	4,921	11,113	1,677
Select hickory	105,146	15,289	19,190	18,547	17,139	15,289	7,299	7,201	2,238	2,954	--
Other hickory	34,093	5,154	6,451	7,044	4,773	5,002	2,056	2,033	1,580	--	--
Basswood	105,761	4,332	7,923	11,520	17,860	13,565	17,881	14,658	7,927	9,412	683
Hard maple	47,078	2,831	3,347	5,831	7,073	5,889	8,855	5,077	3,725	4,450	--
Soft maple	162,653	5,569	8,840	13,235	16,514	20,788	18,172	16,582	14,322	38,471	10,160
Elm	124,688	24,759	22,781	19,672	23,524	14,273	8,071	4,676	2,836	3,754	342
Ash	56,365	5,194	7,007	9,197	8,681	7,985	5,425	2,791	4,133	5,388	564
Cottonwood	149,622	783	4,095	4,186	7,262	8,420	10,912	10,415	12,782	56,802	33,965
Willow	38,639	1,882	3,548	5,108	5,746	6,542	4,355	3,722	3,448	3,774	514
Hackberry	57,083	7,053	8,474	10,329	5,340	9,377	4,188	3,249	3,260	5,454	359
Aspen	18,569	615	1,502	3,900	5,012	3,477	2,693	677	693	--	--
Birch	19,263	1,025	1,588	1,732	2,060	5,109	3,151	2,102	577	1,231	688
Black cherry	19,309	2,158	2,707	2,884	4,492	3,244	2,484	557	253	530	--
Black walnut	63,115	2,796	4,620	9,382	11,970	12,614	7,524	6,161	5,851	2,197	--
Other hardwoods	29,437	3,349	4,361	3,999	4,142	3,592	1,681	1,111	2,934	3,599	669
Total	1,644,881	103,045	145,997	181,044	213,821	224,804	197,398	165,021	117,961	234,314	61,476
All species	1,663,013	110,057	150,789	184,422	215,500	225,318	197,398	165,494	117,961	234,598	61,476

Table 16.--Net volume of growing stock in the saw-log portion of sawtimber trees on timberland by species group and diameter class, Iowa, 1990

(In thousand cubic feet)

Species group	All classes	Diameter class (inches at breast height) 9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods									
Eastern redcedar	5,243	2,741	1,473	302	--	451	--	276	--
Other softwoods	167	--	--	167	--	--	--	--	--
Total	5,410	2,741	1,473	469	--	451	--	276	--
Hardwoods									
Select white oak	229,812	--	29,556	36,653	41,241	43,361	26,773	47,880	4,348
Other white oak	458	--	111	155	192	--	--	--	--
Select red oak	147,025	--	15,307	24,244	27,494	23,125	16,342	33,287	7,226
Other red oak	60,385	--	8,586	12,898	12,346	9,812	4,560	10,545	1,638
Select hickory	42,238	--	12,263	12,334	6,297	6,498	2,067	2,779	--
Other hickory	12,637	--	3,440	4,097	1,788	1,842	1,470	--	--
Basswood	71,594	--	13,638	11,454	15,905	13,467	7,454	9,006	670
Hard maple	30,255	--	5,253	4,879	7,794	4,615	3,472	4,242	--
Soft maple	120,405	--	12,225	17,164	15,954	15,076	13,297	36,743	9,946
Elm	45,734	--	16,606	11,440	6,962	4,197	2,614	3,581	334
Ash	29,640	--	6,325	6,544	4,748	2,528	3,832	5,117	546
Cottonwood	132,400	--	5,595	7,175	9,743	9,612	12,032	54,829	33,414
Willow	23,346	--	4,047	5,128	3,699	3,302	3,156	3,518	496
Hackberry	26,439	--	3,774	7,554	3,626	2,914	3,009	5,211	351
Aspen	10,123	--	3,674	2,836	2,361	613	639	--	--
Birch	12,433	--	1,407	4,092	2,683	1,876	531	1,178	666
Black cherry	8,979	--	3,043	2,569	2,134	498	230	505	--
Black walnut	37,950	--	8,449	10,093	6,471	5,493	5,370	2,074	--
Other hardwoods	14,919	--	2,877	2,816	1,451	991	2,697	3,435	652
Total	1,056,772	--	156,176	184,125	172,889	149,820	109,545	223,930	60,287
All species	1,062,182	2,741	157,649	184,594	172,889	150,271	109,545	224,206	60,287

Table 17.--Net volume of sawtimber on timberland by species group and diameter class, Iowa, 1990

(In thousand board feet) [1]

Species group	All classes	Diameter class (inches at breast height) 9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods									
Eastern redcedar	32,305	18,667	8,723	1,616	--	2,114	--	1,185	--
Other softwoods	938	--	--	938	--	--	--	--	--
Total	33,243	18,667	8,723	2,554	--	2,114	--	1,185	--
Hardwoods									
Select white oak	1,232,753	--	198,280	216,898	224,615	223,398	132,249	219,926	17,387
Other white oak	2,876	--	860	908	1,108	--	--	--	--
Select red oak	810,358	--	99,400	144,347	155,547	126,022	86,805	166,772	31,465
Other red oak	341,730	--	57,542	77,816	69,590	53,042	24,019	52,728	6,993
Select hickory	252,491	--	82,767	74,132	35,427	34,972	10,867	14,326	--
Other hickory	76,921	--	23,731	24,913	10,249	10,159	7,869	--	--
Basswood	407,601	--	90,377	68,271	89,372	72,631	38,803	45,174	2,973
Hard maple	166,547	--	33,829	28,197	42,474	24,114	17,538	20,395	--
Soft maple	580,659	--	71,771	91,091	79,879	72,847	62,645	164,298	38,128
Elm	262,117	--	110,342	65,950	36,379	20,709	12,280	15,266	1,191
Ash	162,679	--	39,314	37,000	25,554	13,260	19,720	25,347	2,484
Cottonwood	693,394	--	34,120	40,934	54,547	52,995	65,917	290,758	154,123
Willow	124,366	--	26,020	29,544	19,561	16,430	15,243	15,643	1,925
Hackberry	138,996	--	24,938	43,344	18,898	14,416	13,991	22,210	1,199
Aspen	60,576	--	23,212	16,955	13,614	3,409	3,386	--	--
Birch	67,365	--	9,497	23,448	14,411	9,514	2,570	5,159	2,766
Black cherry	52,809	--	20,652	14,888	11,333	2,514	1,149	2,273	--
Black walnut	220,639	--	57,819	60,731	36,037	29,079	27,229	9,744	--
Other hardwoods	80,114	--	19,073	16,488	7,663	5,024	13,108	16,222	2,536
Total	5,734,991	--	1,023,544	1,075,855	946,258	784,535	555,388	1,086,241	263,170
All species	5,768,234	18,667	1,032,267	1,078,409	946,258	786,649	555,388	1,087,426	263,170

[1] International 1/4-inch rule.

Table 18.--Net volume and sampling error of growing stock and sawtimber on timberland by county and species group, Iowa, 1990

Unit and county	Growing stock		Sawtimber	
	Volume	Sampling error	Volume	Sampling error
	Thousand cubic feet	*Percent*	*Thousand board feet*[1]	*Percent*
Northeastern Unit				
Allamakee	89,454	14.0	311,526	16.8
Benton	12,014	38.1	42,622	45.4
Black Hawk	9,607	42.6	33,255	*
Bremer	13,562	35.9	50,096	41.9
Buchanan	12,135	37.9	44,874	44.2
Butler	7,843	47.2	24,089	*
Cedar	17,968	31.2	64,860	36.8
Chickasaw	6,169	*	20,112	*
Clayton	103,757	13.0	392,312	14.9
Clinton	28,001	25.0	105,331	28.9
Delaware	21,651	28.4	81,154	32.9
Dubuque	45,943	19.5	168,949	22.8
Fayette	36,161	22.0	134,496	25.5
Floyd	4,795	*	16,986	*
Grundy	168	*	1,253	*
Howard	7,248	49.1	26,745	*
Jackson	65,507	16.3	236,834	19.2
Johnson	27,024	25.4	99,188	29.7
Jones	27,605	25.2	98,997	29.8
Linn	42,261	20.3	156,017	23.7
Mitchell	7,344	48.8	26,928	*
Scott	7,978	46.8	27,607	*
Tama	19,149	30.2	67,102	36.2
Winneshiek	45,667	19.6	167,761	22.9
Total	659,011	5.1	2,399,094	6.0
Southeastern Unit				
Appanoose	26,934	25.5	91,044	31.0
Boone	23,399	27.3	82,966	32.5
Clarke	21,653	28.4	66,701	36.3
Dallas	15,425	33.6	48,120	42.7
Davis	32,460	23.2	111,830	28.0
Decatur	35,333	22.2	121,247	26.9
Des Moines	42,994	20.2	152,936	24.0
Guthrie	26,349	25.7	91,892	30.9
Hamilton	6,639	*	23,674	*
Hardin	11,883	38.3	43,521	44.9
Henry	31,048	23.7	111,090	28.1
Iowa	20,506	29.2	68,588	35.8
Jasper	11,620	38.8	37,065	48.7
Jefferson	16,495	32.5	50,500	41.7
Keokuk	28,893	24.6	105,650	28.8
Lee	49,648	18.7	152,318	24.0
Louisa	28,118	24.9	102,446	29.3
Lucas	24,212	26.9	81,495	32.8
Madison	38,258	21.4	132,753	25.7
Mahaska	17,201	31.9	59,503	38.4
Marion	29,729	24.2	103,380	29.1
Mashall	11,841	38.4	42,768	45.3
Monroe	33,820	22.7	99,955	29.6
Muscatine	17,092	32.0	52,457	40.9
Polk	17,393	31.7	61,583	37.7
Poweshiek	5,667	*	16,277	*
Story	7,788	47.4	23,882	*
Van Buren	48,780	18.9	172,394	22.6
Wapello	27,592	25.2	85,587	32.0
Warren	31,377	23.6	107,518	28.6
Washington	17,666	31.4	57,880	38.9
Wayne	11,992	38.2	39,464	47.2
Webster	16,879	32.2	55,517	39.8
Total	786,684	4.7	2,654,001	5.7

[1] International 1/4-inch rule.

(Table 18 continued on next page)

*Indicates that the sampling error was greater than 50 percent.

(Table 18 continued)

Unit and county	Growing stock		Sawtimber	
	Volume	Sampling error	Volume	Sampling error
	Thousand cubic feet	*Percent*	*Thousand board feet*[1]	*Percent*
Western Unit				
Adair	4,537	*	13,654	*
Adams	5,828	*	18,775	*
Audubon	1,785	*	5,850	*
Buena Vista	2,326	*	7,358	*
Calhoun	660	*	873	*
Carroll	3,228	*	12,073	*
Cass	3,576	*	11,348	*
Cerro Gordo	1,668	*	4,795	*
Cherokee	5,734	*	17,121	*
Clay	3,438	*	10,529	*
Crawford	7,103	49.6	25,667	*
Dickinson	408	*	375	*
Emmet	2,156	*	6,488	*
Franklin	3,963	*	11,368	*
Fremont	10,760	40.3	32,980	*
Greene	9,571	42.7	36,298	49.2
Hancock	1,147	*	2,554	*
Harrison	24,368	26.8	86,391	31.9
Humboldt	2,869	*	8,508	*
Ida	247	*	316	*
Kossuth	3,980	*	12,869	*
Lyon	3,187	*	9,107	*
Mills	8,027	46.6	25,984	*
Monona	24,999	26.4	88,080	31.5
Montgomery	3,677	*	13,567	*
O'Brien	2,572	*	9,328	*
Osceola	206	*	886	*
Page	3,777	*	12,264	*
Palo Alto	1,810	*	5,642	*
Plymouth	5,937	*	18,558	*
Pocahontas	1,008	*	3,758	*
Pottawattamie	11,634	38.7	38,428	47.8
Ringgold	8,590	45.1	23,841	*
Sac	1,685	*	5,260	*
Shelby	1,575	*	5,299	*
Sioux	2,338	*	8,581	*
Taylor	4,322	*	12,715	*
Union	10,242	41.3	30,808	*
Winnebago	907	*	3,349	*
Woodbury	12,578	37.3	41,655	45.9
Worth	4,513	*	18,064	*
Wright	4,382	*	13,775	*
Total	217,318	9.0	715,139	11.1
All counties	1,663,013	3.2	5,768,234	3.9

[1] International 1/4-inch rule.

*Indicates that the sampling error was greater than 50 percent.

Table 19.--Net volume of live trees and growing stock on timberland by ownership class and major species group, Iowa, 1990

(In thousand cubic feet)

Ownership class	Live trees				Growing-stock trees			
	All species	Softwoods	Soft hardwoods	Hard hardwoods	All species	Softwoods	Soft hardwoods	Hard hardwoods
Public	234,911	879	131,810	102,222	163,769	--	89,402	74,367
Farmer	1,551,793	24,964	621,422	905,407	988,572	12,031	382,333	594,208
Miscellaneous private	743,330	10,589	322,088	410,653	510,672	6,101	219,383	285,188
All owners	2,530,034	36,432	1,075,320	1,418,282	1,663,013	18,132	691,118	953,763

Table 20.--Net volume of sawtimber on timberland by species group and tree grade, Iowa, 1990

(In thousand board feet) [1]

Species group	All grades	Tree grade			
		1	2	3	Tie and timber
Softwoods					
Eastern redcedar	32,305	--	--	32,305	--
Other softwoods	938	--	--	938	--
Total	33,243	--	--	33,243	--
Hardwoods					
Select white oak	1,232,753	98,431	224,636	363,208	546,478
Other white oak	2,876	--	--	--	2,876
Select red oak	810,358	122,849	236,192	325,945	125,372
Other red oak	341,730	38,152	53,800	137,550	112,228
Select hickory	252,491	7,570	53,810	99,208	91,903
Other hickory	76,921	11,125	11,612	34,010	20,174
Basswood	407,601	69,839	139,632	186,105	12,024
Hard maple	166,547	7,118	24,069	80,131	55,228
Soft maple	580,659	31,089	116,059	247,703	185,808
Elm	262,117	2,492	45,703	100,518	113,405
Ash	162,679	17,673	35,241	76,733	33,032
Cottonwood	693,394	216,239	185,201	245,184	46,770
Willow	124,366	6,221	11,639	63,462	43,044
Hackberry	138,996	18,586	49,159	58,231	13,020
Aspen	60,576	--	6,994	7,950	45,632
Birch	67,365	6,832	6,216	20,801	33,516
Black cherry	52,809	5,089	3,755	36,236	7,729
Black walnut	220,639	36,168	73,530	90,042	20,899
Other hardwoods	80,114	6,134	3,201	32,309	38,470
Total	5,734,991	701,607	1,280,451	2,205,326	1,547,607
All species	5,768,234	701,607	1,280,451	2,238,569	1,547,607

[1] International 1/4-inch rule.

Table 21.--Average net annual growth of growing stock and sawtimber on timberland by Forest Survey Unit and major species group, Iowa, 1974-1989

Unit	Growing stock				Sawtimber			
	All species	Softwoods	Soft hardwoods	Hard hardwoods	All species	Softwoods	Soft hardwoods	Hard hardwoods
	Thousand cubic feet				*Thousand board feet*[1]			
Northeastern Unit	16,716	602	7,403	8,711	80,530	626	31,603	48,301
Southeastern Unit	21,418	136	11,291	9,991	94,392	559	41,685	52,148
Western Unit	5,884	115	3,970	1,799	21,966	466	13,483	8,017
All Units	44,018	853	22,664	20,501	196,888	1,651	86,771	108,466

[1] International 1/4-inch rule.

Table 22.--Average annual removals of growing stock and sawtimber on timberland by Forest Survey Unit and major species group, Iowa, 1974-1989

Unit	Growing stock				Sawtimber			
	All species	Softwoods	Soft hardwoods	Hard hardwoods	All species	Softwoods	Soft hardwoods	Hard hardwoods
	Thousand cubic feet				*Thousand board feet*[1]			
Northeastern Unit	10,813	30	4,050	6,733	42,836	77	14,630	28,129
Southeastern Unit	10,347	128	5,028	5,191	37,268	397	18,419	18,452
Western Unit	2,947	--	2,187	760	10,340	--	8,232	2,108
All Units	24,107	158	11,265	12,684	90,444	474	41,281	48,689

[1] International 1/4-inch rule.

Table 23.--Average net annual growth and average annual removals of growing stock on timberland by species group and Forest Survey Unit, Iowa, 1974-1989

(In thousand cubic feet)

Species group	All Units		Northeastern Unit		Southeastern Unit		Western Unit	
	Growth	Removals	Growth	Removals	Growth	Removals	Growth	Removals
Softwoods								
Eastern redcedar	719	158	468	30	136	128	115	--
Other softwoods	134	--	134	--	--	--	--	--
Total	853	158	602	30	136	128	115	--
Hardwoods								
Select white oak	5,535	5,280	1,906	2,207	3,121	2,596	508	477
Other white oak	-6	--	--	--	-6	--	--	--
Select red oak	3,766	2,809	2,087	1,990	1,678	770	1	49
Other red oak	2,467	1,018	631	330	1,734	657	102	31
Select hickory	2,705	1,102	912	716	1,519	359	274	27
Other hickory	1,081	255	470	128	518	104	93	23
Basswood	2,417	547	1,387	547	849	--	181	--
Hard maple	709	786	688	757	21	29	--	--
Soft maple	6,360	3,879	2,106	923	3,993	2,536	261	420
Elm	5,187	2,071	1,695	1,477	2,295	227	1,197	367
Ash	1,611	677	942	392	357	217	312	68
Cottonwood	3,725	2,701	653	354	1,809	1,306	1,263	1,041
Willow	659	625	-177	64	650	369	186	192
Hackberry	3,251	456	845	71	1,702	295	704	90
Aspen	233	200	213	200	20	--	--	--
Birch	-139	34	-29	34	-110	--	--	--
Black cherry	709	315	530	256	162	59	17	--
Black walnut	2,257	553	960	256	832	227	465	70
Other hardwoods	638	641	295	81	138	468	205	92
Total	43,165	23,949	16,114	10,783	21,282	10,219	5,769	2,947
All species	44,018	24,107	16,716	10,813	21,418	10,347	5,884	2,947

Table 24.--Average net annual growth and average annual removals of sawtimber on timberland by species group and Forest Survey Unit, Iowa, 1974-1989

(In thousand board feet)[1]

Species group	All Units		Northeastern Unit		Southeastern Unit		Western Unit	
	Growth	Removals	Growth	Removals	Growth	Removals	Growth	Removals
Softwoods								
Eastern redcedar	1,591	474	566	77	559	397	466	--
Other softwoods	60	--	60	--	--	--	--	--
Total	1,651	474	626	77	559	397	466	--
Hardwoods								
Select white oak	35,928	20,441	12,685	8,676	19,512	10,629	3,731	1,136
Other white oak	63	--	--	--	63	--	--	--
Select red oak	24,630	12,505	13,180	9,587	10,937	2,693	513	225
Other red oak	12,869	3,100	3,555	1,100	8,922	1,905	392	95
Select hickory	9,027	3,380	3,753	2,609	4,587	639	687	132
Other hickory	2,637	723	1,044	297	1,443	313	150	113
Basswood	13,067	2,248	6,478	2,248	5,320	--	1,269	--
Hard maple	5,074	3,205	4,564	3,134	510	71	--	--
Soft maple	28,821	14,432	9,068	3,297	18,139	9,521	1,614	1,614
Elm	7,583	6,950	4,942	5,155	2,771	542	-130	1,253
Ash	5,747	2,676	3,388	1,781	1,404	749	955	146
Cottonwood	20,211	12,699	3,867	1,685	9,693	6,225	6,651	4,789
Willow	3,658	917	296	265	1,823	580	1,539	72
Hackberry	7,951	1,628	2,518	233	3,665	1,090	1,768	305
Aspen	2,119	560	2,084	560	35	--	--	--
Birch	786	85	440	85	346	--	--	--
Black cherry	2,441	676	1,998	676	158	--	285	--
Black walnut	9,930	2,177	4,979	1,158	3,524	758	1,427	261
Other hardwoods	2,695	1,568	1,065	213	981	1,156	649	199
Total	195,237	89,970	79,904	42,759	93,833	36,871	21,500	10,340
All species	196,888	90,444	80,530	42,836	94,392	37,268	21,966	10,340

[1]International 1/4-inch rule.

Table 25.--Average net annual growth and average annual removals of growing stock on timberland by ownership class and major species group, Iowa, 1974-1989

(In thousand cubic feet)

Ownership class	Growth				Removals			
		Species group				Species group		
	All species	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Other softwoods	Soft hardwoods	Hard hardwoods
Public	4,813	121	3,152	1,540	4,042	--	2,771	1,271
Farmer	26,011	458	13,121	12,432	14,442	158	5,988	8,296
Other private	13,194	274	6,391	6,529	5,623	--	2,506	3,117
All owners	44,018	853	22,664	20,501	24,107	158	11,265	12,684

Table 26.--Average net annual growth and average annual removals of sawtimber on timberland by ownership class and major species group, Iowa, 1974-1989

(In thousand board feet)[1]

Ownership class	Growth				Removals			
		Species group				Species group		
	All species	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Other softwoods	Soft hardwoods	Hard hardwoods
Public	21,345	--	12,422	8,923	14,431	--	9,678	4,753
Farmer	113,475	1,251	45,977	66,247	53,390	474	21,137	31,779
Other private	62,068	400	28,372	33,296	22,623	--	10,466	12,157
All owners	196,888	1,651	86,771	108,466	90,444	474	41,281	48,689

[1] International 1/4-inch rule.

Table 27.--Average annual mortality of growing stock and sawtimber on timberland by species group, Iowa, 1974-1989

Species group	Growing stock	Sawtimber
	Thousand cubic feet	*Thousand board feet* [1]
Softwoods		
Eastern redcedar	65	172
Other softwoods	9	--
Total	74	172
Hardwoods		
Select white oak	878	1,863
Other white oak	9	--
Select red oak	1,145	3,993
Other red oak	768	2,479
Select hickory	309	1,015
Other hickory	221	399
Basswood	450	1,525
Hard maple	69	255
Soft maple	1,532	4,628
Elm	5,381	11,417
Ash	616	1,729
Cottonwood	1,195	4,709
Willow	1,356	3,880
Hackberry	194	413
Aspen	351	680
Birch	784	2,613
Black cherry	103	185
Black walnut	168	240
Other hardwoods	505	1,226
Total	16,034	43,249
All species	16,108	43,421

[1] International 1/4-inch rule.

Table 28.--Removals,[1] net annual growth, and inventory of growing stock on timberland, Iowa, 1990, and low removals option projections[2] to 2020

(In million cubic feet)

Year	All species		
	Removals	Growth	Inventory
1990	24.7	50.9	1,663.5
2000	28.1	54.4	1,813.9
2010	29.7	56.8	1,957.3
2020	31.9	60.5	2,085.8

[1]Timber removals include volume "lost" due to land clearing, flooding, thinning, or changes in land use, in addition to timber cut and used.

[2]Based on the following assumptions: (a) total area of timberland will decline an average of 0.63 percent between 1990 and 2020; (b) the intensity of management will increase slightly over time; (c) the volume of other removals will drop during the projection period as more of these trees are used for products; (d) average growth rates will decline slightly, from 3.1 percent in 1989 to 2.8 percent in 2020.

Table 29.--Removals,[1] net annual growth, and inventory of growing stock on timberland, Iowa, 1990, and high removals option projections[2] to 2020

(In million cubic feet)

Year	All species		
	Removals	Growth	Inventory
1990	24.7	50.9	1,663.5
2000	33.8	52.8	1,761.5
2010	36.5	52.8	1,819.8
2020	39.2	51.3	1,833.7

[1]Timber removals include volume "lost" due to land clearing, flooding, thinning, or changes in land use, in addition to timber cut and used.

[2]Based on the following assumptions: (a) total area of timberland will decline an average of 0.63 percent between 1990 and 2020; (b) the intensity of management will increase slightly over time; (c) the volume of other removals will drop during the projection period as more of these trees are used for products; (d) average growth rates will decline slightly, from 3.1 percent in 1989 to 2.8 percent in 2020.

Table 30.--Sampling errors[1] for Forest Survey Unit totals of average net annual growth and average annual removals, Iowa, 1974-1989

(In percent)

Forest Survey Unit	Growing stock		Sawtimber	
	Growth	Removals	Growth	Removals
Northeastern Unit	7.2	11.2	7.6	10.9
Southeastern Unit	7.3	15.5	7.9	17.5
Western Unit	13.7	26.1	16.8	28.6
State	5.0	9.1	5.6	9.7

[1] Sampling errors for area of timberland and volume of growing stock and sawtimber, by county, may be found in tables 3 and 18.

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The third Iowa forest inventory found 2.1 million acres of forest land in 1990, of which 1.9 million acres is timberland. Growing-stock volume on timberland increased from 1.1 to 1.7 billion cubic feet between 1974 and 1990, a gain of 46 percent. Presents analysis and statistics on forest area, timber volume, growth, removals, mortality, and projections.

KEY WORDS: Area, volume, growth, removals, mortality.

Our job at the North Central Forest Experiment Station is discovering and creating new knowledge and technology in the field of natural resources and conveying this information to the people who can use it. As a new generation of forests emerges in our region, managers are confronted with two unique challenges: (1) Dealing with the great diversity in composition, quality, and ownership of the forests, and (2) Reconciling the conflicting demands of the people who use them. Helping the forest manager meet these challenges while protecting the environment is what research at North Central is all about.